Engineering News

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San Diego's Municipal Stadium

By F. A. Rhodes*

During the past spring there was completed in the city of San Diego, Calif., a large stadium, the cost of which was defrayed by the city. The structure will comfortably seat 28,000 people. The field has a ¼-mi. cinder track next the railing, inside of which are the football gridiron and the baseball diamond. The athletic building is divided into four compartments (for men, boys, women and girls), each with dressing room, lockers and showers. The building incloses a patio large enough for a handball or basketball court. The location of the stadium in proximity to the high school makes it a valuable adjunct to that institution.

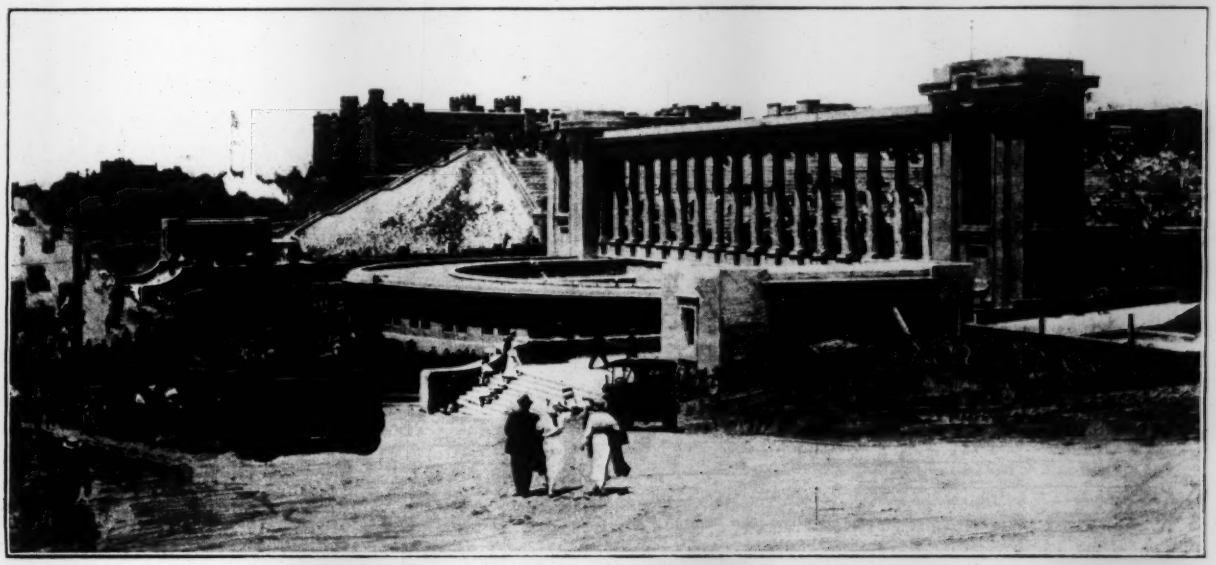

FIG. 1. ENTRANCE TO MUNICIPAL STADIUM AT SAN DIEGO, CALIF.

The sum of $150,000 was voted by the people of San Diego to provide a stadium for Balboa Park. Elaborate plans for a combination stadium and Greek theater were prepared by Quayle Bros. & Cressey, architects, the understanding with the stadium committee being that should their plans exceed the bond issue the difference would be raised by private subscription. When the bids were opened before the Board of Park Commissioners, it was found that the lowest was $325,000. The park board refused to award the contract unless the committee raised $175,000. Meanwhile the board called in the writer and requested that some method be worked out to save $30,000 or $40,000 in the grading of the site.

The site of the work was the southern end of the park where Fifteenth St. ended at the south park line. Fifteenth St. was a graded and improved street in a built-up district, but it was so graded that at A St. (the first street south and parallel with the park line) the drainage from all directions went to this intersection. The proposition to raise the grades of Fifteenth St. from B St. to the park line and of A St. on each side of Fifteenth as far as necessary and to fill in the adjoining property, raise the houses, etc., was put before the property owners. This change of grade was to provide a short haul for waste excavation from the stadium and give a continuous surface drainage from the stadium south on Fifteenth St. The property owners accepted $3000 to cover the cost of replacing sidewalks and curbs and raising their houses, which they preferred to do individually, the park board to furnish the dirt to fill the streets and property to the new elevations. The property owners lost about $4000 by not accepting the board's offer to do this work for them.

As a short haul on the excavation was the solution of the money-saving problem, so far as the earthwork was concerned, it was necessary to make the excavation and embankment quantities balance. This was done by building up the embankments on each side of the field to carry the concrete seats. The slopes on the inside were finished 30 to 17 and on the outside 2 to 1. The cut was trimmed 30 to 17 and in the north end was conical. The grading specifications provided that these fills be in 6-in. layers thoroughly wet and tamped. The dirt was dumped from the wagons, spread by a mormon scraper, rolled with a

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petrolithic roller, thoroughly wet and then rolled again. The contours of the site are shown in light lines in the plan in Fig. 2. The excavation consisted of about 18 in. of topsoil, below which was a layer of hardpan about 18 in. thick. Below the hardpan a soft sandstone was encountered. In this sandstone were pockets of white sand and at a depth of 40 ft. was a layer of sea shells cemented in sand. The sandstone required loosening for the 60-ton 1½-yd. shovel, but by the time it had received the final rolling it had all dissolved to sand, containing just enough clay to bind it.

Two tests were made before the commencement of the work to determine if possible the percentage of volume of fill over cut. The first test was made by carefully cutting out a cubic yard in place and putting it in a yard box and thoroughly tamping it dry as the box was filled up. The fill swelled 20 per cent. over the cut. In the next sample, water was used in tamping, and the fill swelled but 10 per cent. over the cut. It was not thought advisable, however, to depend on the 10 per cent. swell of the fill and possibly be short of material on the wind-up. The estimated quantities adopted were 119,842 cu.yd. excavation and 118,175 cu.yd. embankment, an excess excavation of 1,667 cu.yd. The final quantities worked out remarkably close to this estimate. It was arranged to take care of any further excess or a shortage by raising or lowering the elevation of the stadium field without affecting any of the other work.

In finishing no changes were made in the field elevation, which was at El. 125 (Fig. 2), as the contractor disposed of the excess material. The test for swellage showed about 60 per cent. hardpan and 40 per cent. sandstone, whereas the total yardage contained about 95 per cent. sandstone and 5 per cent. hardpan. The sandstone dissolved to a sand containing a slight amount of clay and resumed the same volume in embankment as in place.

The topsoil was first stripped from the entire site and put into three piles, two at the upper end and one in the center of the field, at approximately the finished grade elevation. This top soil was afterward spread over the field and the outer exposed surfaces that are to be covered with verdure.

The bulk of the dirt was handled by one 1½-yd. railroad shovel and one ⅝-yd. revolving shovel, delivering into 2-yd. wagons. The average haul was about 500 ft. and the work was so arranged that all except about 30,000 yd. was on a downhill haul. When the west fill reached the point where the grade was too steep for the teams to pull up the loads, a cable was installed that enabled the empties returning to the shovel to assist the loaded teams to the top of the embankment. The slopes were trimmed to grade with a fresno scraper attached to the center of a cable, which passed through a block at both the toe and the heel of the slope. A team was hooked to each end of the cable and the scraper hauled up empty and loaded on downward trips. A portion of the slopes was also plowed in this manner.

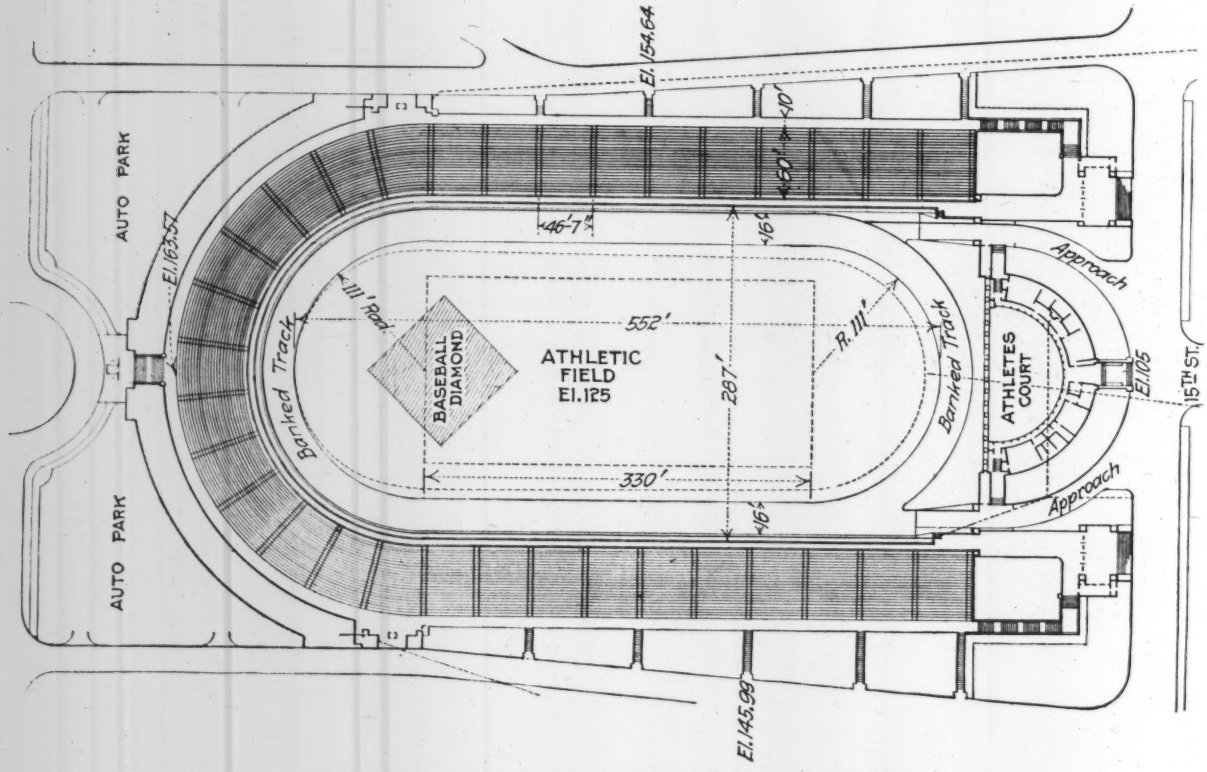


FIG. 2. PLAN OF THE SAN DIEGO MUNICIPAL STADIUM

The general layout of the stadium with its structures is shown in Fig. 4. The original design was revised to the extent of eliminating the Greek theater and the reinforced-concrete seats, but otherwise was not changed. The structures comprise a horseshoe-shaped series of seats—25 steps in all—made of concrete laid directly on the ground, step approaches at intervals along the outside slope, a rear entrance, a side entrance with toilet rooms attached and an elaborate front entrance of reinforced concrete (see Fig. 1) containing locker rooms, etc., and an imposing colonnade.

FIG. 3. EXCAVATING WORK IN PROGRESS ON THE SAN DIEGO MUNICIPAL STADIUM.

The seats were cut out of the slopes (Fig. 6), commencing at the toe, and the concrete run six steps at a pouring. This method required one form for the face of the riser. The vertical joints were made by inserting sheet-iron strips dipped in oil in the wet concrete and pulling them when the concrete had set (Fig. 4). The horizontal joints were made by placing a strip of tarred paper on top of the riser, which was left in the concrete. The joints were put in to provide for a possible settlement in the embankment, to prevent bridging and irregular cracks and to facilitate any possible repair work. Each block can be removed and repoured if damaged. Some of the seats and risers have been in place eleven months; but they show no distortion nor cracks, other than the paper or cut joints.

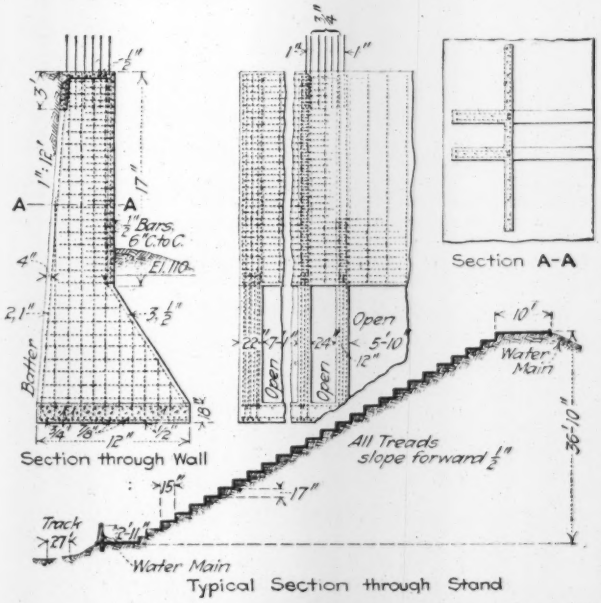


FIG. 4. DETAILS OF STEPS AND OF RETAINING WALL UNDER ENTRANCE COLONNADE

The concrete walk at the top of the steps drains to the seats; each row of seats has a ½-in. fall toward the field and drains to the lower concrete walk. This lower walk carries the water south, out over the two main entrance steps, where it empties into storm drains. The top walk and all the seats are laid on the same rate of grade as the lower walk. All drain to the south end of the stadium as well as toward the lower walk.

The field drains to a catch basin in the south end, and water is led out under the wall and athletic building to the main storm drain, which catches the storm waters from all the stadium roads.

The railing around the field carries a 2-in. water-main equipped with hydrants for washing down the seats. There is also a water line outside the top walk for the same purpose.

Retaining Wall Under Colonnade

The concrete wall at the south end of the field was designed to carry 16 columns, 25 ft. high, supporting a continuous cornice 8 ft. high and at the same time to retain a 16-ft. fill on its north side; the south side is used for playing handball. Fig. 4 shows the design and Fig. 5 the early part of this construction. The wall was made in one

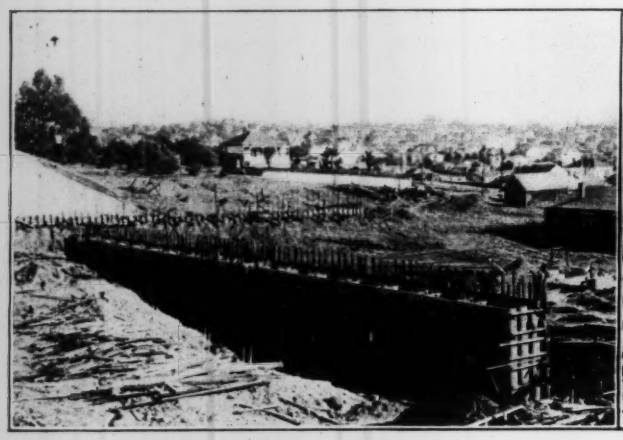


FIG. 5. RETAINING WALL UNDER CONSTRUCTION

FIG. 6. LAYING STEPS FOR SAN DIEGO STADIUM

continuous pouring and has no joints. The face of the wall extends down from the top 17.25 ft., being 1 ft. below the finished grades on the south side of the wall, the foundation for the buttresses going from 1 to 12 ft. deeper.

The concrete mix used was one part cement, two parts washed river sand and four parts river gravel, crushed to ¾-in. size and washed. When the forms were stripped the wall presented smooth surfaces without pockets. This same mix was specified for the concrete seats and risers.

Bids were called for on the entire work, but in two parts—(1) grading and (2) general construction—with the provision that the park board reserved the right to do the grading work itself or let the contracts separately. The contract was let in two parts for $11,050 less than the lowest bid for the entire job. The basis for the earthwork bids was 110,000 cu.yd. excavation and 7,000 cu.yd. topsoil, and the two lowest bids were as follows:

F. O. Engstrum Co.:	
110,000 cu.yd. excavation at 35c	$38,500
7,000 cu.yd. topsoil at 35c	2,450
All other work	72,694
Total bid	$113,644
C. L. Hyde Construction Co.:	
110,000 cu.yd. excavation at 24c	$26,400
7,000 cu.yd. topsoil at 50c	3,500
All other work	93,000
Total bid	$122,900
Contracts as let:	
To C. L. Hyde Construction Co., for grading	$29,900
To F. O. Engstrum Co., all other work	72,694
Total contract	$102,594

The actual amount paid the contractors was $9,044.68 more than these figures, because of excess yardage over the basis of the bid, force account work, and extras on general construction.

In addition the cost of engineering, superintendence, architects, damages, inspection, advertising, blueprints, stationery, photographs, hardware, water meter, planting and other improvements was not covered by the contracts.

Quayle Bros. & Cressey did all the architectural designing and to them should be given the credit for all the utility, conveniences and beauty of the entire structure. H. S. Ervay and the writer worked out all the engineering problems, including the grades, seats, retaining wall, drainage and estimated costs. It was necessary, of course, to work in conjunction with the architects to keep the costs within the appropriation. The estimate of cost was $140,000. The park commissioners retained the writer as Engineer and Superintendent of Construction until the completion of the work. It was dedicated to the public, May 31, 1915, at which time about 20,000 people were seated in it.

The Average Discharge of the Tennessee River at points in North Carolina and Virginia where the river joins the Ohio has been investigated by the United States Geological Survey during the past year, and the findings were recently reported. The average flow of the river at its mouth is 63,000 cu.ft. per sec. This figure was determined by averaging the figures of a 39-yr. period (1875 to 1913). The report gives the daily flow at Chattanooga since 1874; at Florence, Ala., since 1895, and at Johnsonville, Tenn., since 1890. The average discharge at Chattanooga is 33,400 sec.-ft.; at Florence, 38,400; at Johnsonville, 42,000. The Geological Survey has also reported on the areas drained by important rivers in the neighborhood of the Tennessee. The Cumberland River drains an area of 17,900 sq.mi.; the Tennessee, 40,700; the Kanawha, 12,200; the Miami, 5410; the Wabash, 32,900, and the Allegheny, 11,700.

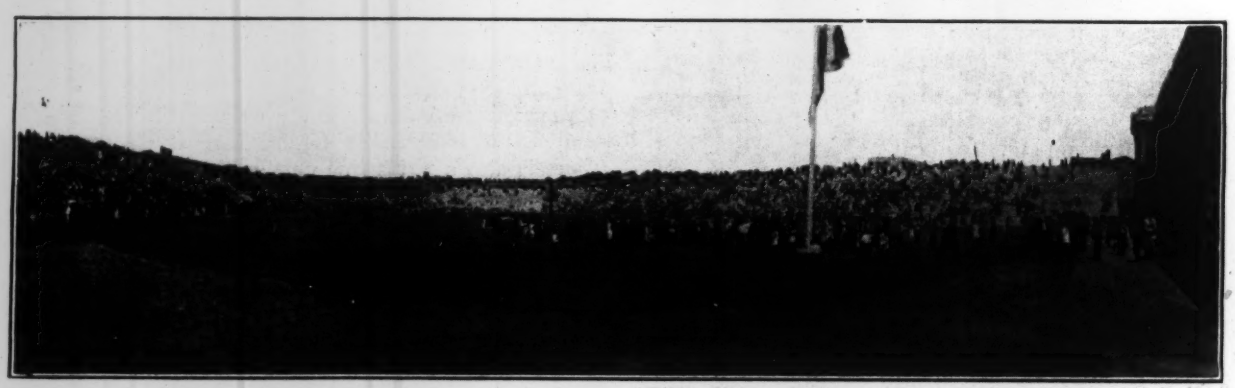


FIG. 7. THE COMPLETED SAN DIEGO MUNICIPAL STADIUM WITH ITS OPENING-DAY CROWD

Drainage Pumping Plant with Variable-Speed Drive

The Hartwell Drainage and Levee District has an area of about 10,000 acres in the northwestern part of Greene County, Illinois. The elevation of the bottom land varies from 426 ft. to 440 ft. (Memphis datum) and that of the river varies from 423 ft. to 440.5 ft. Under these conditions it was necessary to levee the district, and as the river is at flood stage during the crop season it is necessary to pump the run-off at these times.

Rainfall and Run-Off in Levee District

The levee extends along three sides of the district, and has a total length of 13 mi. It is 4 ft. above the highest known water, and has a slope of 1 on 3 for the river side and 1 on 2 for the land side, with a crown of 6 ft. Its only break is at the gravity outlet at the southwest corner of the district. This is a concrete structure with wing walls to hold back the fill and three 42-in. riveted steel pipes provided with hand-operated sluice gates. The elevation of the bottom of these pipes is 421.3 ft. and the top of the concrete wall is level with the levee top.

The rainfall in this section averages about 35 in. per year. The run-off is about 31%, but as there is considerable seepage from the river, 36% was used in estimating the pumpage. The pumping plant was designed to remove ¼ in. of rainfall from the entire watershed in 24 hr.

The run-off is conveyed by open ditches and tile drains. The main ditch leading direct to the pumping plant and gravity outlet is 11,284 ft. long. It has a bottom width of from 35 to 22 ft. and a depth of from 13 to 8 ft. Lateral No. 1, which empties into the main ditch, is 16,632 ft. long and from 12 to 24 ft. wide on the bottom, with an almost constant depth of 9 ft. Lateral No. 2, a continuation of the main ditch, is 13,130 ft. long, from 22 to 18 ft. bottom width, and averages 8 ft. deep. Lateral No. 3, another branch of the main ditch, is 11,150 ft. long, with other dimensions similar to No. 2. The bank slope of all the ditches is 1 on 1, and the fall varies from 0.5 to 1.2 per mile. The main ditch proper terminates at the suction bay, a branch leading off to the gravity outlet about 300 ft. south of the pumping station.

A general cross-section of the pumping station is shown in Fig. 1. The suction bay is built of 1:3:5 concrete, reinforced in both the floor and walls with triangular-mesh expanded metal. The floor is 12 in. thick, and the back and end walls are 4.5 ft. at the base.

The trash-rack (which has not yet been built owing to the immediate need of pumping) will extend across the main ditch 75 ft. east of the suction bay. It will consist of a concrete foundation and cutoff wall and concrete piers carrying steel I-beams to hold the tops of steel bars, $\frac{5}{16}$x1¾ in., spaced 2 in. c. to c. The lower ends of these will rest on the concrete foundation.

The back wall of the suction bay forms part of the building foundation. The remainder of the foundation is 1:2:5 concrete. The 6-in. floor of the building is of 1:2½:5 concrete, reinforced with woven wire netting. Level with the top of the floor and extending 7 ft. below it are the foundations for the pumps and motors. The building is 65x30 ft. in plan with brick walls and a slate roof. A 5-ton traveling crane runs on 10-in. I-beams carried by pilasters along the west wall and 12-in. I-beams on steel columns along the center of the building.

The three pumps, made by the Alberger Pump & Condenser Co., are of the double-suction, centrifugal, horizontal-shaft, volute type, with 30-in. discharge. These are shown in Fig. 2. The impellers are of bronze. The 24-in. suction pipes are of ¼-in. steel plates. They extend through the floor and back wall of the suction bay, and have bell ends 12 in. from the floor of the bay. The 30-in. discharge pipes are of similar construction. They extend through the west wall of the building (Fig. 3) and converge on curves of 21 ft. from 20 ft. to 5 ft. c. to c. at the top of the levee, and then run parallel with each other down the levee and through the back wall of the discharge bay. The ends are provided with flap valves (Fig. 1).

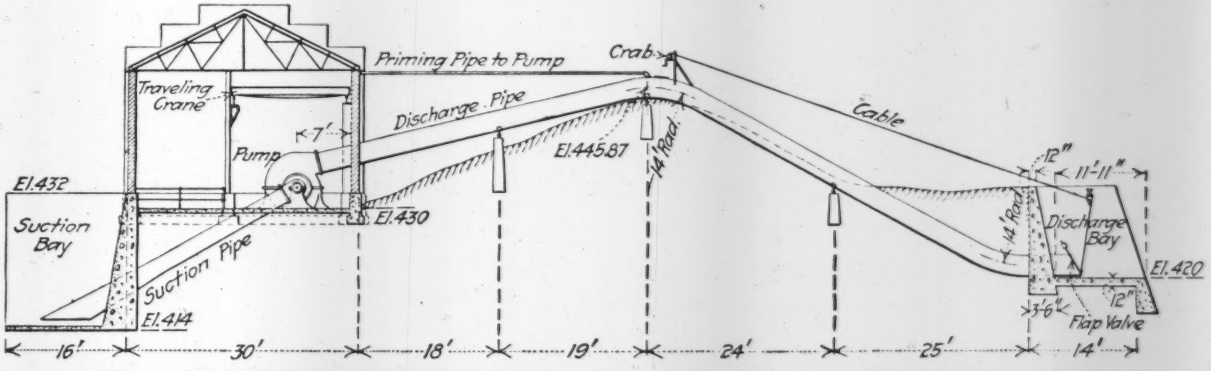


FIG. 1. CROSS-SECTION OF PUMPING PLANT FOR DRAINING THE HARTWELL LEVEE DRAINAGE DISTRICT, ILLINOIS

The pumps have 2-in. drain pipes running from the bottom of the volute under the floor to a common valve box built in the floor, and are drained into the suction bay. The pumps are guaranteed for a capacity of 22,500 gal. per min., an efficiency of 75% at 21-ft. total dynamic head and 300 r.p.m.; 68% at 12 ft. head, 251 r.p.m., and 58% at 8 ft. head, 251 r.p.m.

Pump Drive and Speed-Change Device

Each pump is driven by a 150-hp. 12-pole motor of the slip-ring type for 2,200-volt three-phase 60-cycle alternating current. They run at 600 r.p.m. with no load. They are guaranteed to withstand a voltage of 5,000 volts for one minute and to have a full-load efficiency of 90%, with an 89% power factor. They are connected to the pumps by 44-in. Morse silent chains of 2-in. pitch, which are guaranteed to give an efficiency of

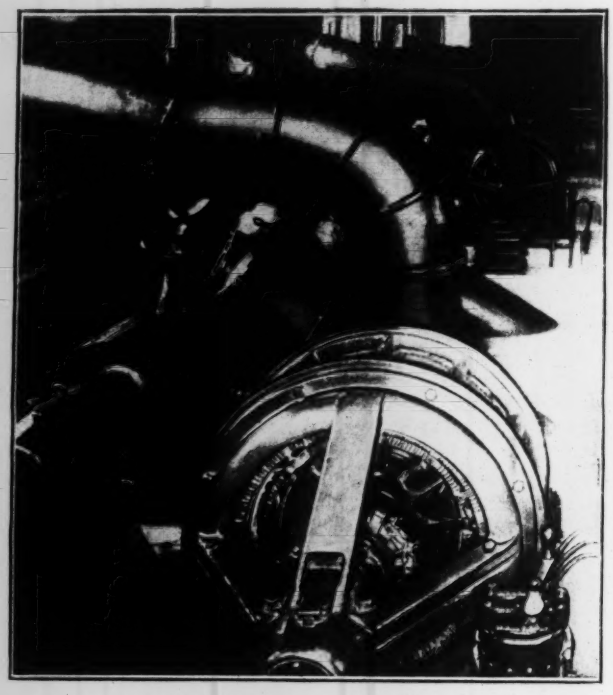


FIG. 2. DRAINAGE PUMPING PLANT WITH CHAIN DRIVE FROM ELECTRIC MOTORS TO CENTRIFUGAL PUMPS

98%. Each motor is equipped with pulleys of three sizes to give the pumps the speed required at the various heads. Power is supplied by the Northwestern Power Co., of Keokuk, Iowa, and is transmitted to Hull, Ill., at 110,000 volts, two-phase. There it is transformed and goes through a frequency changer and is transmitted from there at 33,000 volts, three-phase. The total distance of transmission is about 120 mi. The substation is in the northeast corner of the pumping station.

The pipes for priming the pumps are taken from the discharge pipes on top of the levee, 3-in. air lines being brought into the building overhead and through a safety tank 10 ft. long and 36 in. diameter to a compressor run by a 10-hp. motor. The purpose of the tank is to catch the entrained water. The pipe from the vacuum pump is taken out at the top of the tank. This method has proved superior to the barometric column method.

This is said to be the largest drainage pumping plant on the Illinois River, and probably the largest electrically operated drainage pumping plant in the country.

Method of Varying Pump Speed

The speed of the pumps is varied to suit the conditions of water level by changing the chain sprocket on the motor shaft. Three pulleys are employed, with diameters of 8.11, 9.06 and 11.27 in., made with a slip fit on the shaft. The apparatus used in making the change is shown in Fig. 4. The sag of the chain is taken out by placing a pair of rigid frames beneath it. The frame for the upper run of the chain is bolted to it at one end, and its other end is raised by the hoisting chain of the traveling crane. The frame of the lower run of the chain is raised by a jack.

The motor is then shifted inward by means of its take-up screws until the pulley is clear of the lugs on the chain. A screwjack device placed on the end of the shaft and hooked over the pulley is used to pull off the latter. The new pulley is lowered into place by a sling from the traveling crane, and another jacking device, which is hooked to the arms of the motor frame, is then used to pull this pulley upon the shaft. The one man in charge of the plant can change the pulleys on all three motors and have the pumps running again in 30 min.

The largest pulleys will seldom be used, probably once in three or four years. The smallest and intermediate pulleys will be interchanged probably three or four times a year. The pumps (with small pulleys in place) were started March 20, and ran for 60 days before it was necessary to apply the intermediate pulleys on account of high water. These remained in use during the exceedingly rainy period and consequent high-water stage of the river. At the beginning of the dry season in the fall the small pulleys will be replaced and will probably continue in service until next spring.

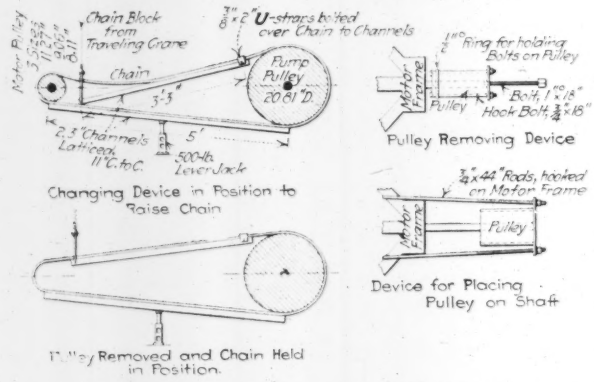

Chain Block from Traveling Crane
Chain
Pump Pulley 20.61" D.
3'-3"
5'
2.5" Channels Latticed 11" C. to C.
500-lb. Lever Jack
Changing Device in Position to Raise Chain
Pulley Removed and Chain Held in Position
U-straps bolted over Chain to Channels
Ring for holding Bolts on Pulley
Motor Frame
Pulley
Bolt, 1" x 18"
Hook Bolt, ¾" x 18"
Pulley Removing Device
¾" x 44" Rods, hooked on Motor Frame
Device for Placing Pulley on Shaft

FIG. 4. APPARATUS USED IN CHANGING THE CHAIN SPROCKET PULLEYS ON THE MOTOR SHAFT TO VARY THE SPEED OF THE PUMPS

The tests so far made have been insufficient to determine exactly the friction head. The present instructions

FIG. 3. DISCHARGE PIPES OF DRAINAGE STATION AND OVERHEAD LINES FOR PRIMING PUMPS

to the operator are to use the small pulleys for heads of from 0 to 4 ft., the intermediates for from 4 to 10½ ft., and the large pulleys for heads above 10½ ft. These are static heads only.

Operation and Engineering

There is a brick dwelling, about 300 ft. from the pumping station, for the use of the operator, who is also supplied with a motor boat. He is employed 12 months in the year and is required to send daily reports to the district engineer on the form (7¼x5½ in.) shown in Fig. 5.

Hartwell Drainage and Levee District
Greene County, Illinois

PUMPING RECORD

Weather..... Month..... Day..... Year.....
Rainfall..... Inches..... 191

	Hours Run	Time of Running	Pulley No.	R. P. M.	Approximate Amperage
Pump No. I					
Pump No. II					
Pump No. III					

Total Meter Reading 6:00 P. M. .....
K. W. H. used .....

River Gauge Reading 7:00 A. M. ..... Ft.
Ditch " " 7:00 A. M. ..... Ft.
River " " 6:00 P. M. ..... Ft.
Ditch " " 6:00 P. M. ..... Ft.
Average head ..... Ft.

Caldwell Engineering Co.
Engineers
Jacksonville, Illinois

Operator

FIG. 5. DAILY-REPORT FORM, HARTWELL STATION

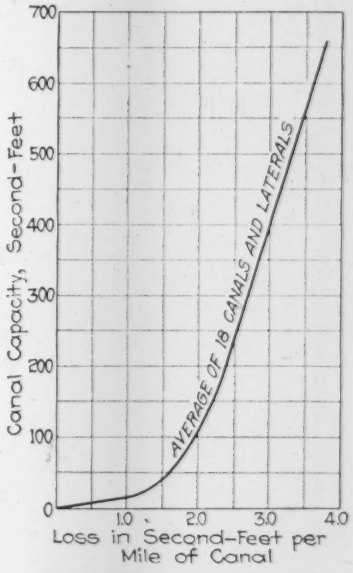
These works were designed by H. L. Caldwell, Chief Engineer of the Caldwell Engineering Co., Jacksonville, Ill., and were built under the supervision of S. J. Dalton, Jr., Field Engineer. The contractors were as follows: Levee reinforcing, Barston & Millard, Peoria, Ill.; pumping station, Arrow Engineering Co., St. Louis, Mo.; gravity outlet, J. D. Weaver, Jacksonville, Ill.; ditches, R. H. & G. A. McWilliams, Chicago, Ill.

Transmission Losses in Modesto Irrigation Canals

By Kenneth A. Heron*

Where open unlined earth canals are used for the distribution of water in an irrigation system a large part of the water appropriated is lost in transmission between the source of supply and the farms. To determine just what this loss amounts to in the Modesto Irrigation District, in California, a series of measurements was made by me during the irrigation season of 1914.

Owing to the warm summer temperature and the sandy formations and soils of the district, the transmission losses were found somewhat higher than is ordinarily the case. These losses are divided into those from seepage, evaporation and leakage. The evaporation loss is such a small part of the seepage loss that no effort was made to distinguish between the two, which were combined and called seepage. The following general methods were pursued in determining the seepage losses. A time was selected when the flow of a lateral or canal had been constant for some hours. It was then measured with an A. Lietz current meter at the head, or at the high end of the portion of the lateral or canal section under observation. Measurements were made at points lower down after such periods of time as it was computed would be required by the same water that was last measured to reach the new measuring point. As some of the canal sections under observation were as much as nine miles in length an entire day was frequently required to obtain the measurements on one lateral. All visible losses from the canal, such as leaks through boxes, water turned out of the canal into another canal and leaks through banks, were carefully measured. Large irrigation heads (average 20 sec.-ft.) are used in this district, and consequently the flow in laterals is not subject to as many variations as is the case where a large number of small heads are drawn from a lateral. After the last measurement was made on the low end of the section under observation, it was ascertained if the intake discharge at the high end of the section had remained constant. Where any material change happened the measurements were repeated.



TRANSMISSION LOSSES BY SEEPAGE AND EVAPORATION

All the most important canal and main lateral transmission losses were checked by a system of daily gage readings and measurements, which were carried on throughout the season. As a result of all the measurements made, the accompanying curve has been drawn to show the average loss per mile in canals and laterals of various capacities. In a number of instances the results were quite different from what the curve would indicate, but cases of this kind were explained by local conditions.

It is thought that this curve represents average conditions in generally sandy areas such as exist in the San Joaquin and Sacramento Valleys in California.

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Industrial Accident Statistics—The industries which contribute the greater number of fatal accidents are railway employments and agricultural pursuits, each group being responsible for approximately 4,200 fatalities a year. Coal mining contributes more than 2,600, and building and construction work nearly 1,900. General manufacturing, while employing large numbers, produces only 1,800 fatal accidents. When the fatality rates are considered, metal mining ranks as most hazardous, with a rate of 4 per 1,000; coal mining coming next, with 3.5, and fisheries and navigation following with a rate of 3 per 1,000. Manufacturing industries as a whole rank lowest, with a rate of 0.25. The United States Bureau of Labor Statistics of the Department of Labor has just issued, as Bulletin 157, a report on this subject by Frederick L. Hoffman. The conclusion reached is that the number of fatal industrial accidents among American wage-earners, including both sexes, may be conservatively estimated at 25,000, and the number of injuries involving a disability of more than four weeks at approximately 700,000.

Revised Cross-Sections for Illinois Roads

By H. E. Bilger*

SYNOPSIS—An analysis of the highway problem of Illinois and the Middle West, where good local material for roadbuilding is scarce. Discusses how an attempt has been made to solve these problems as economically as possible by devising types of brick and concrete roads to fit rural conditions.

The proposed system of state-aid roads in Illinois comprises some 15,000 mi. and includes the main rural highways in each of the 102 counties of the state. With a construction problem of this magnitude and rapidly changing traffic conditions the important matter is not to complete the entire system within a specified time, but to construct in each locality roads of such types and dimensions as economically to satisfy present traffic requirements, and in addition be susceptible of reasonable modification to meet the requirements of the future.

SIX-FOOT EARTH SHOULDERS AND LARGE SIDE DITCHES FOR SURFACE DRAINAGE, 18-FT. CONCRETE ROAD, ILLINOIS HIGHWAY COMMISSION

In a state having a gross area of 55,000 sq.mi. there is such a wide variety of conditions as to admit the economical construction of very many different types of highway. Therefore it is not practicable, nor even desirable, to attempt the design of standard cross-sections to cover all the conditions encountered. Nevertheless, a certain number of these cross-sections constitute the group most frequently used, and which are termed "standard."

The necessary width of right-of-way is governed largely by the topographic conditions, but also by the type of the proposed improvements. On rural highways paved with brick or concrete there can be found no condition in the proposed Illinois state-aid system that will properly admit of a right-of-way narrower than 40 ft. It is highly desirable that the minimum width of right-of-way for all main traveled county roads be 50 ft. Cuts and fills will in many cases require a width of 60 or 70 ft., or even more.

Where a highway crosses a valley it is particularly desirable that the width of right-of-way be ample to afford space for borrow-pits, in order that the necessary material may be provided economically for the construction of the embankment. For this additional width the cost of farm land, even at $300 or $400 an acre, is almost negligible when compared with the expense necessarily incurred where filling material must be moved for a distance of over 300 ft.

Since the true function of a highway is not the transportation of freight at a minimum cost, it is evident that great expense in making grades easier than about 3 per cent. is not warranted by traffic considerations alone. Excessive cuts in order to provide an easy gradient through ordinary ridges merely add difficulties to the drainage problem.

Except for comparatively short lengths over ridges, it is particularly desirable that the width of graded roadway be not less than 28 ft. in order to provide for the maintenance of an earth road on each side of the pavement, where this has only a 10-ft. width. For probably at least nine months of the year weather conditions in Illinois admit of the economical maintenance of an earth road to a degree of perfection that induces the greater portion of the traveling public to abandon the pavement.

If the graded roadway is less than 28 ft. in width it becomes necessary to construct the pavement off the center line of the highway and have the entire earth roadway on one side. One objection to this is that in going in a certain direction the loaded vehicle on the pavement is

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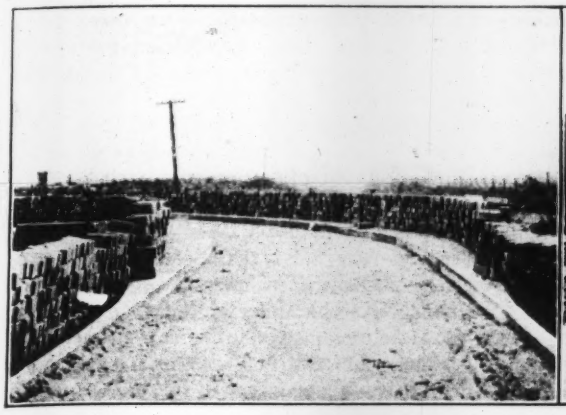
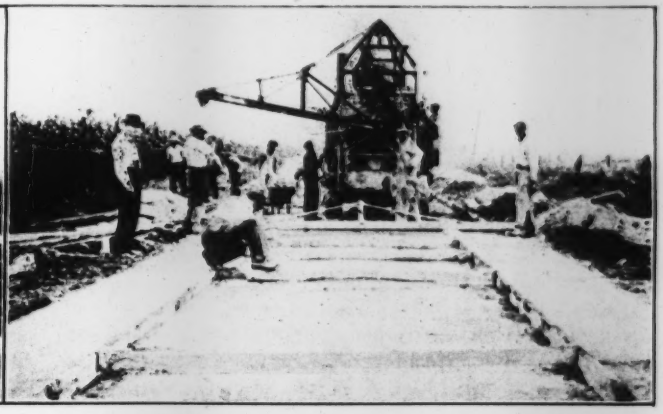


BUILDING 3-FT. CONCRETE SHOULDERS AT CROSS-ROADS



WIDENING CONCRETE SHOULDERS TO 3 FT. AT CROSS-ROADS

required to take to the earth road almost entirely, for the vehicle coming in the opposite direction has practically no opportunity to turn out, even though it be empty. A counteracting objection to a pavement on the center line is the necessity for maintaining two parallel earth roads.

It yet remains to be proved whether it is more economical to maintain an earth road 15 ft. wide, and accommodating traffic in both directions, than to maintain two earth roads each 9 ft. wide. Considering the possibilities of future development, it would seem that the pavement should be at least approximately in the center of the highway.

Wherever practicable the side ditches are constructed with a 2-ft. horizontal base 2 ft. lower than the crown of the finished pavement. The horizontal base is not always economically practicable, but is dependent largely upon the character of the soil and also upon the contractor's facilities for doing the work. A V-ditch is about 6 in. deeper than the flat-bottom ditch. Its additional capacity is practically negligible, but under certain soil and other conditions it can be more economically built by machine work than the flat-bottom ditch.

For short stretches over ridges the width of the graded roadway may economically be narrowed to about 18 ft. as a minimum, if provision is to be made for two lines of traffic. The practicability of this construction depends largely on the omission of deep ditches on the ridges, where but a very small amount of water needs to be taken care of by the surface drains.

Discussion of New Cross-Sections

Cross-Section 1—The 10-ft. concrete pavement is particularly applicable for light or medium horse-drawn traffic, where the loaded vehicles move largely in one direction and the pleasure vehicles are more or less equally divided with respect to their direction of travel. Except for a small amount of slow-moving traffic, 10 ft. is the narrowest width a concrete pavement should ever have in Illinois, even on a level tangent.

Concrete pavements which are only about 8 ft. wide, where the coarse aggregate used is of sedimentary origin, readily yield along the wheel tracks under moderate steel-tired traffic. The 10-ft. width affords more or less opportunity for distribution of the wear, and consequently this width of pavement is more durable. The combination of conditions that make the adoption of a 10-ft. cross-section advisable is not so common in Illinois as might be inferred from the general preference given it by officials in many of the counties.

Durability and Width of Pavement

Inasmuch as the durability of a concrete pavement is measured largely by the wearing qualities of the coarse aggregate used, it is evident that under Illinois conditions, where practically the only coarse aggregate available is limestone or dolomite, there are no very strong arguments for a 10-ft. concrete pavement where horse-drawn traffic is heavy. Were diabase or other forms of good igneous rock available, the situation would be somewhat modified. A sandy clay soil for the shoulders favors a 10-ft. width, while gumbo and buckshot soils discourage its adoption.

Cross-Section 2—This is identical with cross-section 1, except that the roadway is on a fill and is only 28 ft. wide. The reason for the reduction of the width is to meet the many cases that arise where funds are not available for more expensive first-cost construction, and also to keep the embankment within the limits of the highway.

Cross-Section 3—The use of this cross-section is intended to be confined to short lengths of road over ridges. Excessive expense due to excavation is avoided by providing a graded roadway only 18 ft. in width, and by meeting the drainage requirements with concrete gutters. This cross-section virtually provides an 18-ft. roadway,

CONCRETE GUTTERS OF 16-FT. BRICK ROAD

since the shallow concrete gutters take the traffic as well as the pavement proper. This construction is adopted only where little water is to be cared for.

Heretofore this cross-section was designed with grouted macadam gutters, but the impracticability of constructing gutters of a type other than that of the pavement was soon demonstrated. While the 15-ft. concrete pavement is being laid there is but little additional labor expense incurred in laying the concrete gutters as a part of the pavement.

During construction the placing of the concrete in the pavement proper is always just a few feet in advance of the gutter. The thin forms along the line of the pavement proper are removed as soon as the concrete for the gutters has been placed; consequently they become part of the pavement. The economy of this cross-section is not at once appreciated from the office point of view, but becomes established when considered from the contractor's viewpoint.

The grouted macadam gutters cannot be constructed simultaneously with the pavement because time has to be given for the concrete to season. This delay, in addition to the new labor operations, equipment, etc., to be employed in constructing the grouted macadam gutters, practically demands the substitution of concrete.

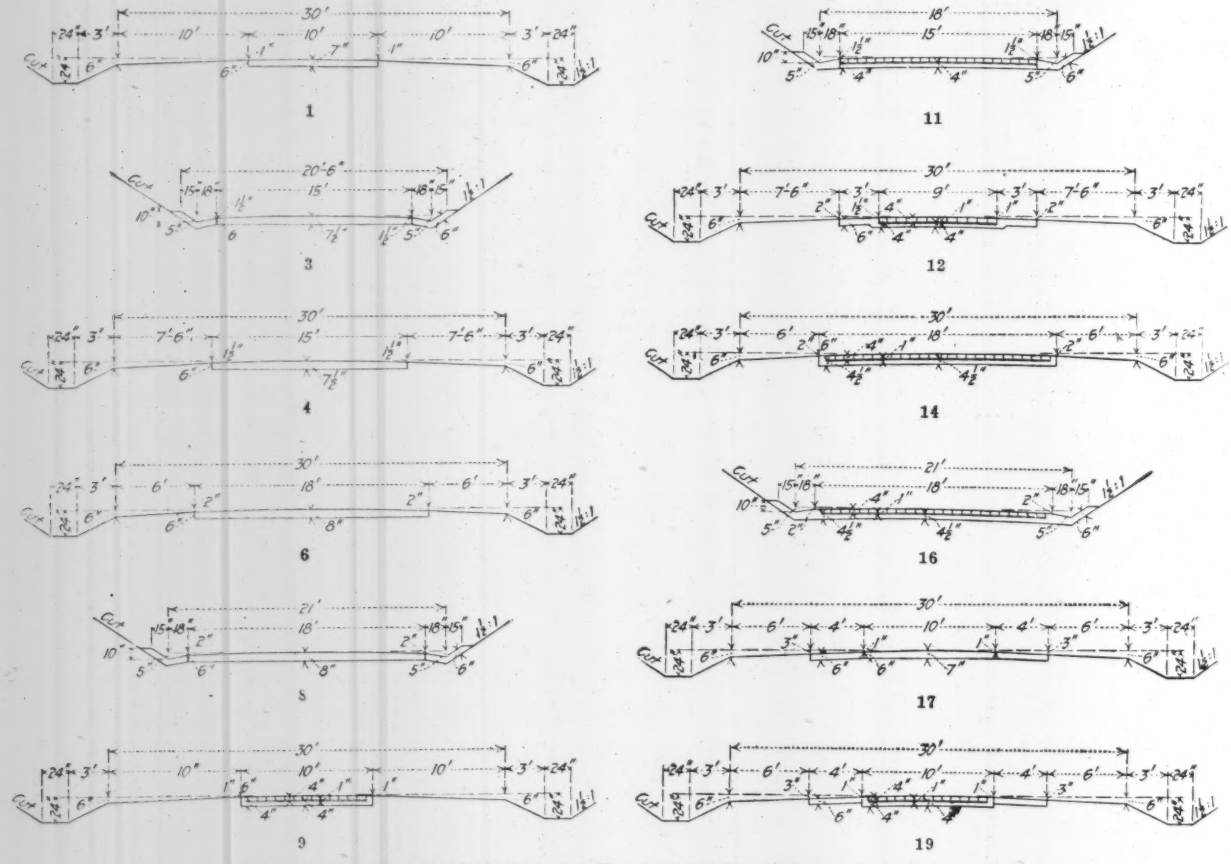
This cross-section is applicable for all motor-traffic conditions and for all reasonably heavy horse-drawn traffic conditions where there are two lines of traffic.

Cross-Section 4—The 15-ft. width of concrete pavement is rapidly growing in favor in Illinois. This width satisfactorily admits of two lines of horse-drawn traffic, and answers with more or less satisfaction the requirements of two lines of motor traffic at normal speeds when such traffic is not very dense.

Cross-Section 5—This is practically identical with cross-section 4, except that it is for a roadway on an embankment 32 ft. in width. The most developed areas of Illinois require a graded roadway, even on comparatively high embankments, of not less than 32 ft. in width. These cross-sections are not strictly consistent, but are designed to meet local requirements and preferences.

Cross-Section 6—Except under extremely dense traffic conditions, cross-section 6 owes its existence entirely to the motor vehicle. For two fast-moving lines of motor traffic safety requires that the width of the pavement be not less than 18 ft. An 18-ft. concrete or brick pavement constructed on a highway upon which there has never been a pavement of any kind can only mean a sudden revolution of traffic conditions. Logically this type would be reached by successive developments of less expensive construction and of narrower widths.

Cross-Section 7—This is identical with cross-section 6, except that the roadway is on an embankment and is 32 ft. in width.

Cross-Section 8—Like cross-section 3, this is especially applicable for short lengths over ridges. The virtual roadway is 21 ft. It would seem that conditions are not frequently encountered that would warrant the adoption of this cross-section, because of the additional width provided.

NEW ROAD CROSS-SECTIONS NOS. 1 TO 19, ILLINOIS HIGHWAY COMMISSION

Cross-Section 9—It will be noted that, beginning with cross-section 9, the variation from the preceding cross-sections is confined almost entirely to the character of the pavement. In addition to being applicable under all conditions noted under cross-section 1, it is also suitable for the most severe horse-drawn traffic to be found in any rural community in Illinois.

As a rough average it has been found that the contract price of the pavement proper (cross-section 9) over and above that of the concrete cross-section 1 is about 70c. per sq.yd. Cross-section 9 makes use of local aggregates for the concrete, which as a rule are less expensive than the imported. Local sand, gravel and stone in Illinois are not always acceptable for concrete pavements, but with judgment they can usually be employed with safety and economy in the construction of concrete bases for brick.

A probable additional point in favor of cross-section 9 is that its width may be readily increased at any time future conditions demand. The probable life of a brick pavement is such that while only a 10-ft. width is originally warranted, its future widening may be accomplished while the pavement is still far from worn out.

Cross-Section 10—This is identical with cross-section 9, except that the roadway is on an embankment and is only 28 ft. in width.

Cross-Section 11—This corresponds with cross-section 3. The virtual roadway provided is 18 ft. in width. The remarks relating to the concrete gutters of cross-section 3 apply also to this type. The concrete gutters are constructed as a part of the concrete base and are of the same materials and mixture. Considering the small amount of traffic that comes upon these gutters, and also the fact that much of this is motor traffic having rubber tires, it is quite probable that the length of life of the gutters approaches that of the brick pavement.

Cross-Section 12—This is a development of the narrow brick pavement with macadam shoulders. As in the construction of grouted macadam gutters, it was found in practice that gravel or macadam shoulders are not often economical or advisable in conjunction with a brick or concrete pavement. All materials employed and all operations of construction throughout the entire width of pavement should be identical so far as practicable.

The 3-ft. concrete shoulders are constructed as a part of the base. The mixture for the concrete base is 1 : 3½ : 6, whereas the mixture for the shoulder is 1 : 1¾ : 3. By adopting this mixture for the shoulders the ratio of fine to coarse aggregate remains constant, while exactly twice the amount of cement is required in one batch for the shoulders as in one batch for the base. This simplifies construction operations.

It is anticipated that cross-section 12 will provide the substantial equivalent for the 15-ft. brick pavement and at somewhat less expense. Probably more than 80 per cent. of the horse-drawn traffic will naturally be confined to the 9-ft. width of brick, and the use of the concrete shoulders will be largely for passing.

Cross-Section 13—This cross-section is identical with cross-section 12, except that the roadway is on an embankment and is 32 ft. in width.

Cross-sections 14 and 15—These are types which are demanded by actual necessity in extremely few rural communities in Illinois. Cross-section 15 is identical with cross-section 14, except that it is on a fill and is consequently 32 ft. wide.

Cross-Section 16—With cross-sections 14 and 15, this is representative of as durable a type of rural highway improvement as is commercially possible in Illinois.

Cross-Section 17—Except for rare occasions, this cross-section is destined soon to become obsolete. Cross-section 18 is identical with cross-section 17, except the width of roadway, which is 32 ft.

Cross-Section 19—The macadam shoulders are destined soon to be entirely abandoned, as also in cross-section 20, which is identical with cross-section 19, except the width of roadway, which is 32 ft.

Conclusions—A road cross-section can be designed intelligently only in the light of all the conditions peculiar to the locality in which the road is to be built. Economic procedure in rural highway improvement is measured by the degree of thoroughness of the analysis of the local conditions, and in strict compliance with those conditions.

The work of the Illinois State Highway Department is carried on under the direction of William W. Marr, Chief State Highway Engineer, with whose approval the foregoing is published.

Longitude Determinations of Great Accuracy

By Owen B. French*

During the summer of 1914 the United States Coast and Geodetic Survey determined three differences of longitude with a higher order of accuracy than had been obtained previously. The work was done in coöperation with the Royal Prussian Geodetic Institute of Potsdam, Germany, for the purpose of furnishing a more accurate connection between the longitude nets of America and Europe, and also to secure data sufficiently accurate to show any possible change in the relative positions of the two continents.

When this work was first considered in March, 1912, it was proposed to make the new determination by wireless telegraphy. The observers were to determine the difference of longitude between Cambridge, Mass., and the Azores Islands, using signals sent from Glace Bay, Canada; while German observers were to make the determination between the Azores and Potsdam, Germany, using signals sent from the wireless station at Clifden, Ireland. The distances between the sending stations and their receiving stations are practically equal, so that the time of transmission would be eliminated.

The difficulty in securing suitable recording apparatus for wireless signals and several other considerations caused the abandonment of this plan and the substitution of the method by cable between Far Rockaway, Long Island, N. Y., and Borkum, Germany, including an accurate connection with the longitude net at each end of the cable.

The connection of the cable station at Far Rockaway, N. Y., with the longitude net of the United States was accomplished by Fremont Morse and Owen B. French, of the United States Coast and Geodetic Survey. Two old stations, Harvard College Observatory, Cambridge, Mass., and New Naval Observatory, Washington, D. C., were used for this connection, with a new direct determination also between the old stations, the old work having been done before the transit micrometer came into use in the Coast and Geodetic Survey. Harvard Observa-

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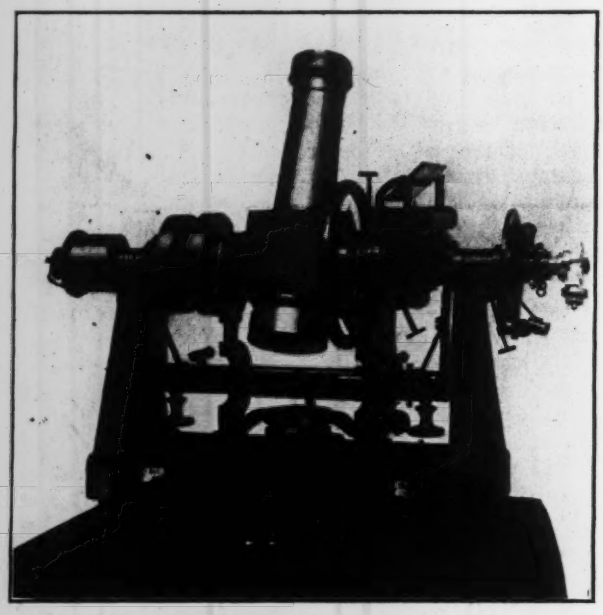


FIG. 1. MOST RECENT TYPE OF TRANSIT INSTRUMENT FOR LONGITUDE DETERMINATION

tory is considered as the initial station for all United States longitudes, as all the old transatlantic longitudes have been connected with it.

New instruments, made by Bamberg, of Berlin, Germany, were received by the Coast and Geodetic Survey just before this work was begun and were used here for the first time. The transits are of the broken-telescope type, with the eyepiece and transit micrometer at one end of the axis (Fig. 1). The frame supporting the telescope axis is low and very rigid, having two supporting screws at either end of one side and a third screw in the middle of the other long side. Although this method of supporting an instrument causes a disturbance of the azimuth whenever the axis is leveled, the instruments proved very stable. The field of the telescope being sufficiently large, the telescope was reversed in the middle of the observation on each star, thus eliminating the necessity for considering collimation and pivot inequality.

The chronographs for receiving the records, made by Fuess, of Berlin, Germany (Fig. 2), are of the fillet type, with electric control for starting and stopping. The whole apparatus was so arranged and wired that the observer could control all the electric circuits while sitting at the telescope without touching the instrument or pier. The electricity for operating the various relays and illuminating the field of the telescope was furnished by dry cells.

At Cambridge and Washington the standard observatory clocks were used. At Far Rockaway the German clock was used for the United States work as well as for the cable work. All the clocks were kept at practically a constant temperature.

The differences of time resulting from this work are:

	Min.	Sec.	Sec.
Cambridge to Far Rockaway.....	10	29.031	±0.0031
Far Rockaway to Washington.....	13	15.704	±0.0028
Cambridge to Washington.....	23	44.738	±0.0024

The error of closure is 0.003, which is smaller than might be expected from the probable errors shown in the last column. These probable errors are not inferior to those obtained in any foreign country and are about half as large as the best previously obtained by the United States Coast and Geodetic Survey, which has charge of all primary longitude work in the United States.

The foregoing results depend upon observations made on eight to ten nights for each line. Errors of star-place were eliminated by observing the same stars at both stations of each line. Three time sets, each consisting of five or six time stars and an azimuth star, were observed each night with two exchanges of signals between stations. The observers exchanged stations near the middle of the observations on each line, each taking his instruments with him every time, thus making the final results practically free from personal equation.

The personal equations on the three lines are: +0.020, —0.001 and +0.004 sec. The first may be considered as due partly to the instruments being new and not in perfectly smooth working condition and slightly to inexperience of the observers with this style of instrument. These observations, therefore, confirm previous statements that observations made with the transit micrometer practically eliminate the need for considering personal equation between the observers.

The old value for the difference of longitude between Cambridge and Washington agrees exactly with the value given. This must be classed as accidental when we consider that the old value was based upon two lines, one of which received a correction of 0.031 sec. and the other of 0.010 sec. in the adjustment of that work. However, the old longitude determinations are of a high order of accuracy, where there was an exchange of observers, as has been shown by several comparisons with work by modern instruments.

In view of the statement that this work was undertaken partly for the purpose of showing a possible change in the relative positions of the two continents, it may be interesting to note that the results recently obtained by observers of the United States Naval Observatory for the difference of longitude between Washington and Paris, using wireless telegraphy, agree more closely with the old transatlantic longitudes than might be expected from the probable errors of the old results, and do not differ enough to furnish proof regarding any change in position of the continents.

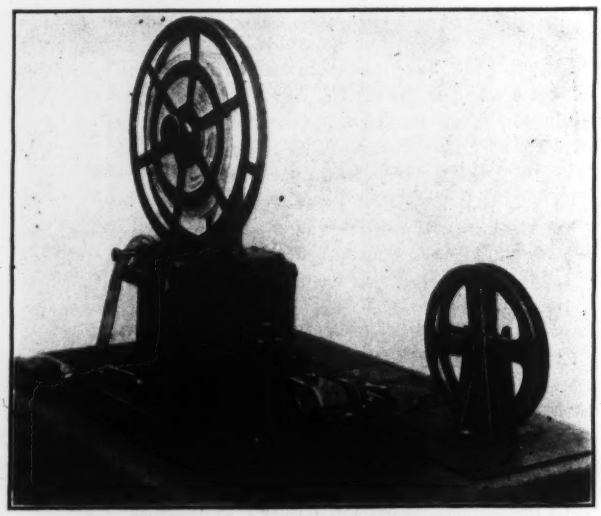


FIG. 2. RECORDING INSTRUMENT FOR LONGITUDE DETERMINATION

Building the Mathis Dams--II

By E. Lauchli*

SYNOPSIS—Notes on the design and construction of a dike dam built upon a reinforced-concrete mattress and having a very deep reinforced cutoff wall. Effect of ground-temperature differences on cutoff-wall stresses.

In creating the Mathis reservoir a small dike dam across a depression leading from the basis was required in addition to the main dam across the Tallulah River. Various structures were considered for closing the gap. One was an earth fill with reinforced-concrete core wall; but this was abandoned for lack of proper material. The soil at and near the site consisted of sand mixed with a very little clay and decomposed mica schist. A masonry dam of the gravity type was out of the question owing to lack of adequate foundations. The design of a reinforced-concrete structure was then prepared, with a cutoff wall 10 to 15 ft. deep and buttresses resting on spread footings.

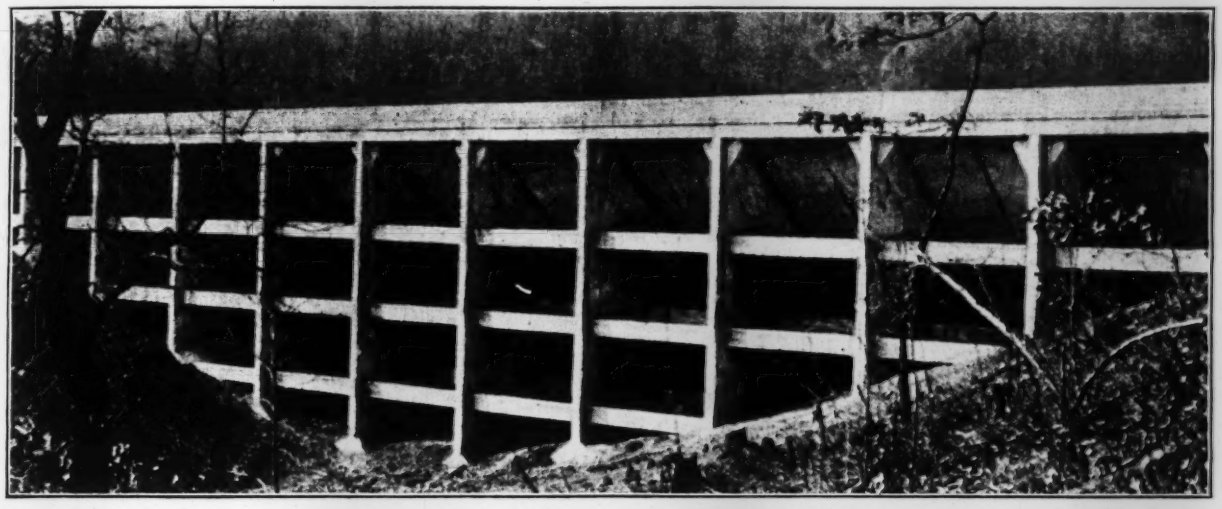


FIG. 1. DOWNSTREAM VIEW OF MATHIS DIKE DAM

Reinforced-Concrete Dam Selected

While this design was being elaborated test pits sunk at various points of the proposed cutoff wall revealed the fact that rock was not available except at great depth, and that the material penetrated was chiefly of the kind referred to before, together with loose rock which weathered rapidly on exposure.

The design was therefore modified to suit these new conditions. The buttresses were spaced 18 ft. c. to c., and instead of spreading their footings, a heavily reinforced concrete mattress was provided (1) to reduce the pressure on the subsoil, (2) to avoid unequal settlements, (3) to prevent the buttresses on the side slopes from moving sideways, and (4) to increase the stability of the structure against sliding.

The pressure on the foundation is uniform with the reservoir empty. With water at El. 1692 (3 ft. allowance being made above maximum level for wave action) the pressure at the heel and toe of the dam is 920 and 1,370 lb. per sq.ft. respectively. The friction coefficient against sliding is 0.47. However, in order to further increase the stability of the structure against sliding, a longitudinal reinforced-concrete rib was provided at the toe and another at the center of the lower side of the mattress. The latter is reinforced with 1-in. corrugated steel bars, placed so as to take care of positive and negative moments. Near the buttresses the depth of the mattress is increased to take care of shearing stresses.

Care was taken to exclude the possibility of water pressure under the mattress. To this end, the cutoff wall was carried down to rock 30 to 57 ft. (except at one end) and its junction with the mattress and deck was amply reinforced. Weep holes were left through the mattress.

Design of the Buttresses and Decks

The buttresses were made of 1:3:6 concrete (the design allowed 300 lb. per sq.in. for concrete in compression and 100 lb. for shear). From the mattresses up to El. 1670 the buttresses are 16 in. thick. and 14 in. above that elevation. Although 10 in. would have been ample to resist the stresses, it was found advisable to increase the thickness to provide ample working room.

When pouring one of the last buttresses, a mixture of 1:2:4 concrete was used. This showed that economy in labor would result by using a rich mixture for work of this kind, as much spading and finishing could thereby be avoided.

The decks were made of 1:2:4 concrete (unit stresses of 600 lb., 60 lb. and 14,000 lb. per sq.in. being allowed for concrete in compression and shear and for tension in steel respectively). As little information was available on the corrosion of steel reinforcement embedded in thin concrete slabs subjected to hydrostatic pressure, it was decided to curve the lower side of the deck, thus making each slab an arch capable of bearing the hydro-

*2 Wall St., New York City.

static pressure, in case of any depreciation of the steel reinforcement which might take place in course of time.

The decks are free to expand or contract horizontally, and strips of asphalted felt are provided between the deck and the haunches so as to insure watertightness. The abutting surfaces of the buttress tongues and of the decks are painted with asphaltum.

Ground Temperature Variations

During construction the question arose as to the possibility of vertical temperature cracks developing in the

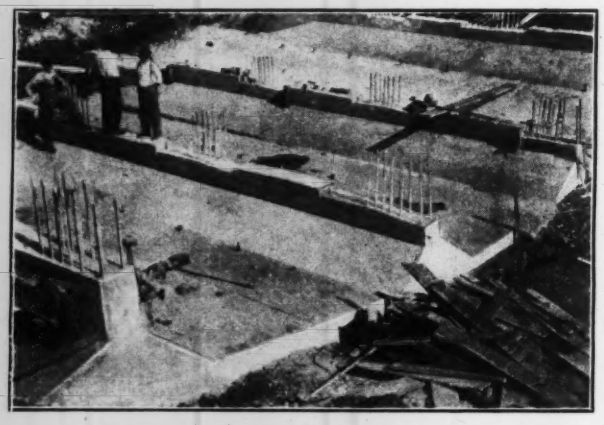


FIG. 2. FOUNDATION MATTRESS FOR DIKE DAM

cutoff wall, which cracks might enable water to find its way under the mattress. The writer carried on a series of observations in bore holes 2.5 to 45 ft. deep to ascertain the variation between ground and air temperature in the vicinity of the structure.

The ground temperature, even in December, at the bottom of the 45-ft. hole was found to be constant at 61.5 deg. F., which is 2.5 deg. higher than the average yearly air temperature here. The temperature recorded at the bottom of the 16-ft. hole ran from 53 to 56 deg. F. It was anticipated that the upper part of the cutoff wall would be subjected to nearly the same temperature variations as water in the reservoir—that is, from about 34 to 60 deg. F. Therefore the upper 15 to 20 ft. was reinforced with $\frac{5}{8}$-in. vertical rods spaced about 2 ft. c. to c. and with 1-in. horizontal rods spaced 12 in. c. to c. At 2.5 to 3 ft. the ground was subjected to practically daily temperature variations; therefore the concrete mattress, in spite of its heavy steel reinforcement, was covered with 3 ft. of earth, so as to minimize the effect of temperature changes.

The decks are of course fully exposed to temperature variations, but are free to expand or contract horizontally. In certain instances, with the reservoir empty, the joints opened from $\frac{1}{16}$ to $\frac{3}{16}$ in. per panel. The beams between buttresses were poured during the summer of 1913. The maximum air temperature was about 110 deg. F. in the sun. During the winter of 1913-14 the minimum air temperatures were from 12 to 15 deg. F., yet only hair cracks were apparent in a few beams.

Methods of Construction

One wooden derrick with a 60-ft. boom and one steel derrick with a 100-ft. boom handled the material excavated from the cutoff trench. The excavation was made with picks and shovels, no blasting being required. The sides of the trench stood well, requiring no bracing or sheeting, even when 57 ft. deep. However, no chance was taken, and enough bracing was provided to protect the crews against a possible cave-in. After rock had been reached, drills were put to work in order to ascertain the nature of the underlying rock. Except in a few instances, a soft solid rock was encountered which disintegrated rapidly when exposed. All bore-holes, except Nos. 8, 9, 10, 11 and 20 (Fig. 4) were carried down with machine drills, the others being churned.

After holes No. 7 and No. 8 had been put down, it was feared that no rock could be found except at great depth, thus necessitating much excavation and concrete, and an attempt was made to drive steel sheetpiling, as shown in Fig. 4. The result obtained can hardly be called successful, and only about 50 lin. ft. was used. It was then decided to provide all test holes with grout pipes, extending these to the surface of the ground, on the downstream side of the deck and to grout the holes under high pressure, should leaks develop with the reservoir full.[1]

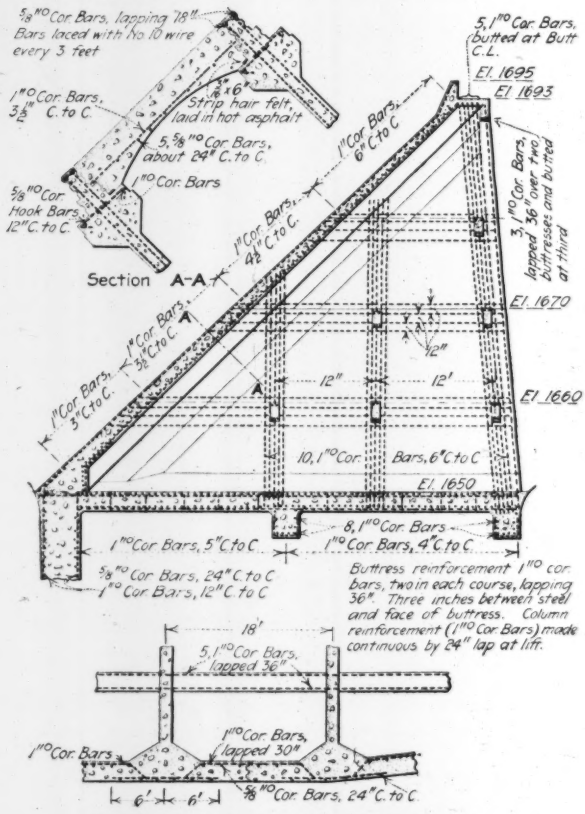

5/8" Cor. Bars, lapping 18" Bars laced with No. 10 wire every 3 feet
1" Cor. Bars, 5½" C. to C.
6"x6" Strip hair felt, laid in hot asphalt
5, 5/8" Cor. Bars, about 24" C. to C.
1" Cor. Bars
5/8" Cor. Hook Bars, 12" C. to C.
1" Cor. Bars, 6" C. to C.
1" Cor. Bars, 4½" C. to C.
Section A-A
1" Cor. Bars, 5/8" C. to C.
1" Cor. Bars, 3" C. to C.
5, 1" Cor. Bars, butted at Butt C.L.
El. 1695
El. 1693
3, 1" Cor. Bars, lapped 36" over Two buttresses and butted at third
El. 1670
½"
12"
12'
El. 1660
10, 1" Cor. Bars, 6" C. to C.
El. 1650
8, 1" Cor. Bars
1" Cor. Bars, 4" C. to C.
1" Cor. Bars, 5" C. to C.
5/8" Cor. Bars, 24" C. to C.
1" Cor. Bars, 12" C. to C.
Buttress reinforcement 1" cor. bars, two in each course, lapping 36". Three inches between steel and face of buttress. Column reinforcement (1" Cor. Bars) made continuous by 24" lap at liff.
18'
5, 1" Cor. Bars, lapped 36"
1" Cor. Bars
1" Cor. Bars, lapped 30"
6'
6'
5/8" Cor. Bars, 24" C. to C.

FIG. 3. DETAILS OF MATHIS DIKE DAM

The cutoff wall was concreted in sections, between wooden bulkheads, the abutting surfaces of the concrete sections being tongued and grooved. A 1:3:6 mixture was used, one-man stones being embedded in it.

The concrete plant (see Fig. 2 of Part I of this article) consisted of a ½-yd. cube mixer, located about 30 ft.

[1]After construction was completed and the reservoir filled to maximum level, the grout-pipe caps were removed and it was found that half of the pipes would discharge from 0.5 to 12 gal. per min. They were then grouted under a pressure of 70 to 85 lb. In general they took comparatively little grout—one to four sacks of cement each, although one or two pipes took from 12 to 16 sacks.

back of the cutoff wall, at the center of the structure. The concrete was handled with derricks, from the mixer to the forms, in special buckets on a car rolling back and forth over a track laid on the top of the buttresses. A 1500-ft. cableway conveyed crushed rock and sand from a construction railroad, 1¼ mi. long, connecting the Tallulah Falls R.R. with the crusher plant at the main dam, a quarter mile above.

About 180 cu.yd. of concrete was laid per week, the maximum being 478 cu.yd. The whole structure involved 4523 cu.yd. of concrete and 288,830 lb. of reinforcing steel—that is, 64 lb. of steel per cu.yd. of concrete. An average of 12,600 lb. of steel was laid per week (six days) and a maximum of 26,000 lb.

As negro labor was used almost exclusively, the inspection was made very rigid, no concrete being laid in the absence of inspectors. The mattress was concreted in sections 18 ft. wide between construction joints located half way between buttresses, beginning with the lowest section. The buttresses were concreted up to a height of 3 or 4 ft. together with the mattress; after that in 10-ft. lifts. The cross struts were poured usually a week or two after a buttress lift.

Timber forms were used throughout; but the arch forms for the lower side of the decks were lined with sheet iron. The decks were concreted in panels extending from buttress to buttress and in lifts of about 10 ft. A 1:2:4 concrete was used in the mattress, decks and cross-beams, and 1:3:6 in the balance of the structure. The specifications called for stones passing through a 2-in. and 2½-in. mesh for the respective mixtures.

The cost of this structure, involving 3100 cu.yd. of excavation and 4523 cu.yd. of concrete, was approximately $75,000, the cost of excavation and concrete being $3.40 and $14.45 per cu.yd. respectively. Cement cost $1.823 per bbl.

C. O. Lenz, Chief Engineer of the Georgia Railway and Power Co., was responsible for the engineering work on the entire Tallulah Falls power development. The late John Birkinbine was retained as consulting engineer on the reservoir project. C. G. Adsit was in charge of the construction work at the Mathis basin with H. T. Hartwell as resident engineer. The writer was in charge of the design of the two dams at Mathis and supervised their construction. The Hardaway Construction Co. was the subcontractor on the dams.

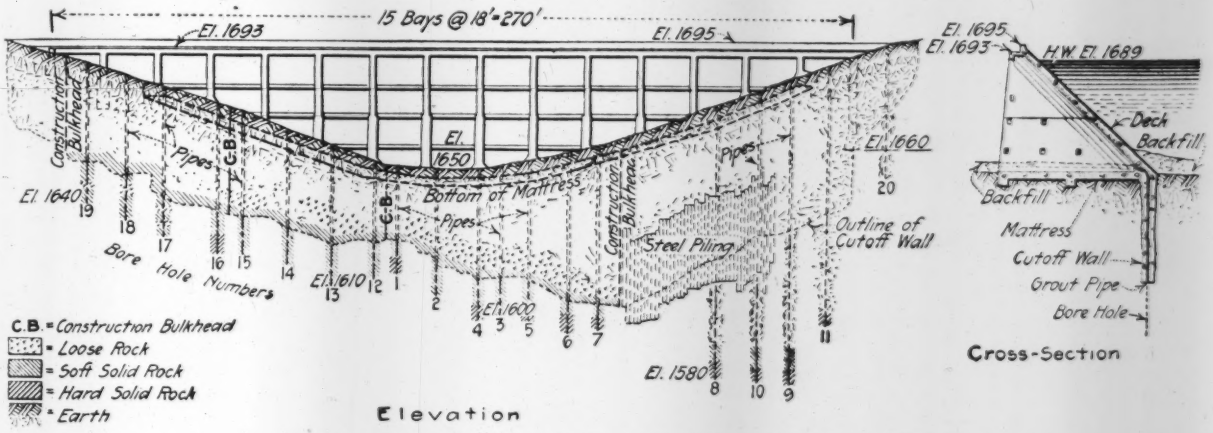


FIG. 4. ELEVATION OF MATHIS DIKE DAM AND FOUNDATIONS

State Control of Sewage-Treatment Works*

As the great majority of sewage-treatment works in America are small and frequently widely separated, it is apparent that the needed expert supervision cannot be obtained locally and that efficiency of operation can only be secured through some central authority. In several states the legislatures have empowered the state boards of health with authority to control the pollution of water-their approval is required before sewerage works can be constructed.

In municipalities where sewage treatment is intrusted to competent, expert employees and where this work has the strong moral and financial support of the citizens, the exercise of state authority and supervision is but little needed. But in such cases the cooperation of state and municipal officials is of mutual advantage.

For the state boards of health to act intelligently they should know the methods of operation and the results accomplished in all the sewage-treatment works in the state. They would then be able to act as clearing houses, supplying to one works the information obtained from several others operating under similar conditions. Such information must, of course, be applied to any particular works by one who is thoroughly conversant with local conditions and able to distinguish the peculiarities and differences involved. The operation of each works is a purely individual matter. Blindly copying, without due analysis of the local conditions, is generally fatal.

The state is interested in seeing that the existing works accomplish the best results possible, and the separate communities are naturally anxious that the works shall meet the requirements at the minimum expense for operation, additions and renewals. To this end, information is required on the following:

1. The purpose of the works; that is, are they primarily intended to protect sources of water-supplies or to prevent the creation of nuisance?
2. The construction of the works; that is, the details of each process that influences operating methods, rather than the stability of the structure.
3. The quantity and character of the sewage to be treated.
4. The methods of operation and the results accomplished.

*From a report of the Committee on Works Operation and Analytical Methods to the Sanitary Engineering Section of the American Public H alth Association, Rochester, September, 1915. The committee was composed of W. L. Stevenson, chairman, C. B. Hoover, F. E. Daniels and four others.

It is practically impossible to recommend a standard form of report blank to cover the many types of apparatus used in sewage treatment. If, however, the report form for each works in a state is prepared to meet the local needs, it can still contain essential data so recorded that reports of operation of similar types of apparatus in different works will be in identical form for comparison.

In preparing such forms it should be borne in mind that the small works are generally operated by employees lacking a technical education, and therefore clearness and simplicity should be obtained by having as much as possible printed, leaving only figures to be filled in.

It is again desired to call attention to the importance of recording essential data. In the majority of sewage-treatment works no provision is made to obtain a record of the rate of flow to the plant, even though such information is vital to proper operation. The committee strongly recommends that engineers in designing new works provide means for easy measurement of the flow and that measuring devices be installed in existing works not now so equipped.

Railway Coal-Storage Plants

Two widely different types of coal storage and handling plants for railway coal supply are described below, and in both of these the coal is stored in open piles.

The deterioration of coal in open piles is not a serious consideration, according to a report to the International Railway Fuel Association by a committee of which Hiram J. Slifer, consulting engineer, Chicago, is chairman. But the coal should be carefully studied to determine the best methods of preventing spontaneous combustion, and it is advisable to store that from different fields in different piles. The report stated that various investigations have shown that with most coals there is very little difference in the heating value whether stored in the open or under cover, while objections to a covering are the increased cost of the plant and probable interference with the handling of the coal.

Louisville & Nashville Railroad Plant

The coal-storage plant designed for the new Radnor yard of the Louisville & Nashville R.R., at Nashville, Tenn., comprises a semicircular coal pile, which is divided by a semicircular track for a locomotive crane.[1] The coal can be filled in over the ends of the track, leaving only a pocket for the crane. The general arrangement is shown in Fig. 1. This plant will serve both the Louisville & Nashville and the Nashville, Chattanooga & St. Louis railroads. The storage pile will contain about 12,300 tons for the former and 8200 tons for the latter, while the coaling station for locomotives will have a 600- and a 400-ton bin for the two roads respectively.

The crane will travel on two tracks of 29¼-in. gage, spaced 18 ft. 11 in. c. to c., and will be mounted on four four-wheel trucks, thus having ample stability for swinging. It will have a long braced steel boom, carrying a 5-yd. grab bucket and having a maximum radius of 110 ft.

Coal will be received in hopper-bottom cars and dumped into a track pit, from which it may be fed directly to the vertical bucket hoist of the coaling station, or it may be picked up by the locomotive crane and deposited on the storage pile. To supply the coaling station the crane takes coal from the pile and drops it into the pit, filling it to such height that the coal will flow by gravity into the automatic feeders of the bucket hoist.

The coaling station will be of reinforced-concrete, with a hoist tower of structural steel. It will serve three engine tracks. In addition to the coal bins, it will have storage for 75 tons of green sand and 10 tons of dry sand. The coal and sand will be raised by duplicate balanced buckets at the rate of 125 tons per hour for both buckets. It will be provided also with four steel weighing hoppers of 15 tons' capacity. The crane will be operated by steam and the hoists by electricity.

A coal-storage and coaling plant of the same type is in operation at Paris, Ky. This has a crane of 80-ft. radius (with 3-yd. bucket) and travels on a single track

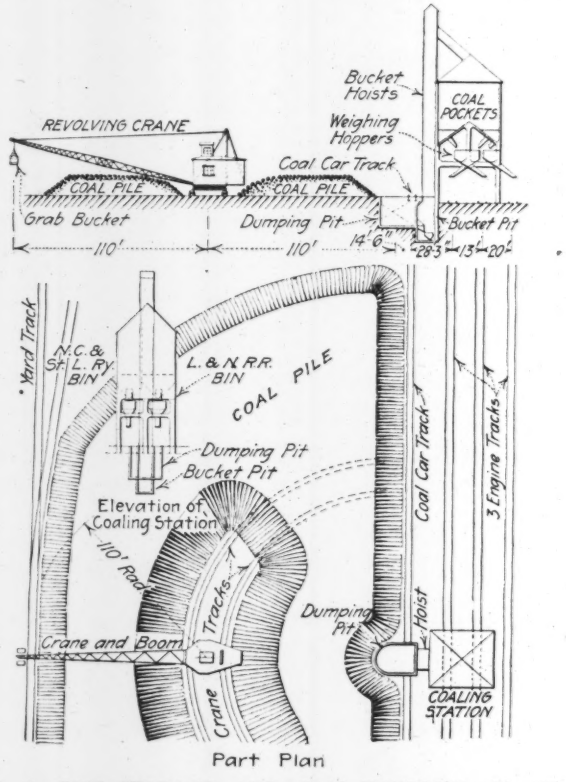


FIG. 1. COAL-STORAGE AND COAL-HANDLING PLANT WITH 110-FT. REVOLVING CRANE AT THE RADNOR YARD, LOUISVILLE & NASHVILLE R.R.

of 15-ft. gage. The coaling station has only a single bin of 400 tons' capacity, and has no weighing hoppers or sand-handling equipment. A similar plant with 110-ft. crane and 600-ton bin is being installed at Lebanon Junction, Ky. The plant at Paris has not been in use long enough (and has not handled enough coal) thoroughly to test the operation and advantages of the scheme, but it is satisfactory as to its mechanical operation. The only special features of the coaling stations used in connection with these storage plants are the open-back dumping pit

[1] This system, with a long-radius locomotive crane running on circular (or segmental) tracks, is patented by the Link-Belt Co., which supplied the cranes for the Louisville & Nashville R.R. here described.

and the unusual depth of the feeder and bucket-hoist pit. The cranes were built by the Link-Belt Co., and the coaling-station machinery by the Ogle Construction Co., of Chicago. The plants were designed and built under the direction of W. H. Courtenay, Chief Engineer of the Louisville & Nashville.

Southern Railway Coal Storage

Several reinforced-concrete coaling stations have been built recently by the Southern Ry., and at three of these provision is made for storing a supply of coal on the ground and handling this by means of drag-line buckets. The storage piles contain from 3000 to 10,000 tons each, with a depth of not more than 10 ft. The general arrangement of the plant is shown in Fig. 2.

The methods of delivering the coal to the storage pile and returning it to the coaling station are quite different from those at the Nashville plant already described. The railway cars dump the coal into a track hopper, from which it is fed by a loading device to an elevating conveyor of the bucket type. This delivers the coal either to the storage bin of the coaling station or to a gravity chute which discharges it at about the center of the storage pile. From this point it is distributed over the area of the pile by the drag scraper, which also delivers coal from the pile to the track hopper and elevator for the supply of the elevated coaling bin.

The storage pile is of irregular form and is surrounded by poles about 20 ft. apart for the attachment of the bucket lines. At the first plant these poles (termed pulling poles) were 20 ft. high, but it was found that poles of such height were not practicable without the use of outside guy lines, which would be undesirable. The height was reduced, therefore, to 12 ft. The poles are made of steel H-beams, each set in a concrete base. They are connected at the top by a row of 7/8-in. rods.

The operation of the scraper bucket is effected by means of a double-drum friction hoist driven by a 25-hp. motor geared directly to the countershaft. The hoist and motor are mounted in a housing in the coaling station or on a steel platform over the coal-receiving track. From the drum a steel hauling cable extends to the bail on the mouth of the bucket. The backhaul cable extends to a block hitched to one of the posts and thence to its attachment to the back of the bucket, as shown.

With this equipment the operator can take the coal delivered from the chute and distribute it between this point and the post to which the snatch-block is attached. To reach the space between two posts, lines may be fastened to them and the snatch-block attached to the lines, as shown in Fig. 2. By shifting the block from pole to pole any point within the coal-storage area can be reached.

When it is necessary to supply the bin of the coaling station, the position of the bucket or scoop is reversed, its mouth (or open end) being turned toward the coaling station, as in Fig. 2, the backhaul cable then becoming the hauling line. In this way coal is carried from the storage pile to the receiving hopper, from which it is fed to the bucket conveyor and elevated to the bin. Each plant is equipped with at least two of these scraper buckets, thus minimizing the work of changing the blocks and tackle.

The coaling station shown in the drawing serves three engine tracks. The main bin has a capacity of 955 tons, and there are three scale pockets of 15 tons each, making a total of 1000 tons. It has also a sand-storage bin, with delivery spouts, so that engines can take coal and sand at the same time. The design of these coaling plants is under the direction of the maintenance-of-way department, and for information and plans thanks are due to H. W. Miller, Vice-President of the Southern Ry.

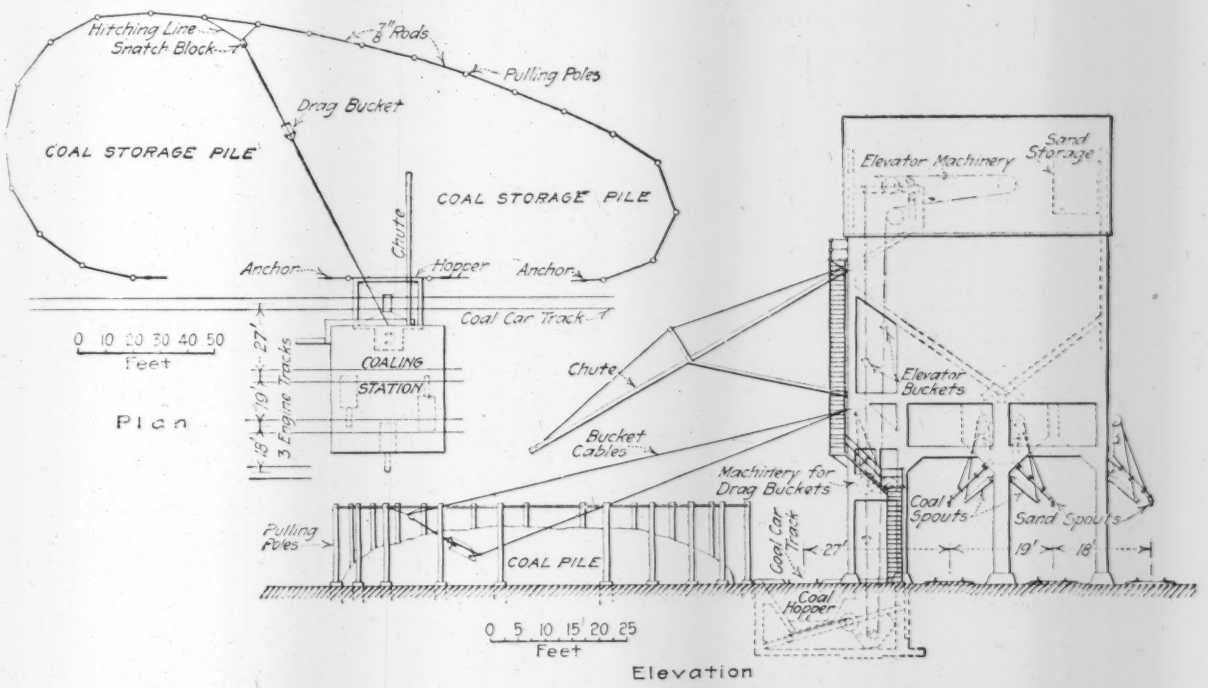


FIG. 2. COAL-STORAGE AND COAL-HANDLING PLANT WITH DRAG-LINE BUCKETS, SOUTHERN RY.

Laying Street-Railway Track Without Ties

By E. R. Horton, Jr.*

SYNOPSIS—The system of construction here described dispenses entirely with the use of ties. The rails are supported by reinforced-concrete girders, to which they are anchored at frequent intervals. Special features are the anchors, the use of continuous bed-plates under the rails, and the use of channel base plates to support the rail joints. The concrete is carried up to form the street paving along the tracks. The general purpose of the design is described and details of cost are given.

The type of track construction for paved streets which is here described, and shown in the accompanying drawings (Figs. 1 and 2), has been designed by the writer as the result of study and experience with low T-rails in concrete track paving on the lines of the Southern Public Utilities Co., of Charlotte, N. C. Acknowledgment is made to Edwin F. Taylor, general superintendent, whose coöperation has resulted in the adoption of this as the company's standard construction.

For the past five years the writer has been engaged in extending, reconstructing and paving the track systems of this company. The types of construction have been varied, but about 15 mi. has been concrete paving with 60- and 70-lb. T-rails. The ballasted cross-tie construction, with two-course concrete, has not been entirely satisfactory except in certain cases where conditions were favorable. Conclusions based upon both the successful and unsuccessful portions of the lines have resulted in the development of the present type. The most important of these conclusions may be stated as follows:

Concrete is satisfactory as track pavement when the track structure is not too flexible, and when very fine dust is excluded from the mixture. One of the most common causes of failure of track pavements is deflection of the rail; low T-rail will deflect on any yielding substructure to such an extent that the paving will be destroyed. Ballast when newly laid (and however thoroughly tamped and rolled) will shake down under traffic, and set up a wave motion in the rail. Therefore, where low T-rail is used, it must be so supported from beneath that the deflection will not be sufficient to injure the pavement. Reinforced concrete is most suitable for this purpose because it is permanent and will not settle.

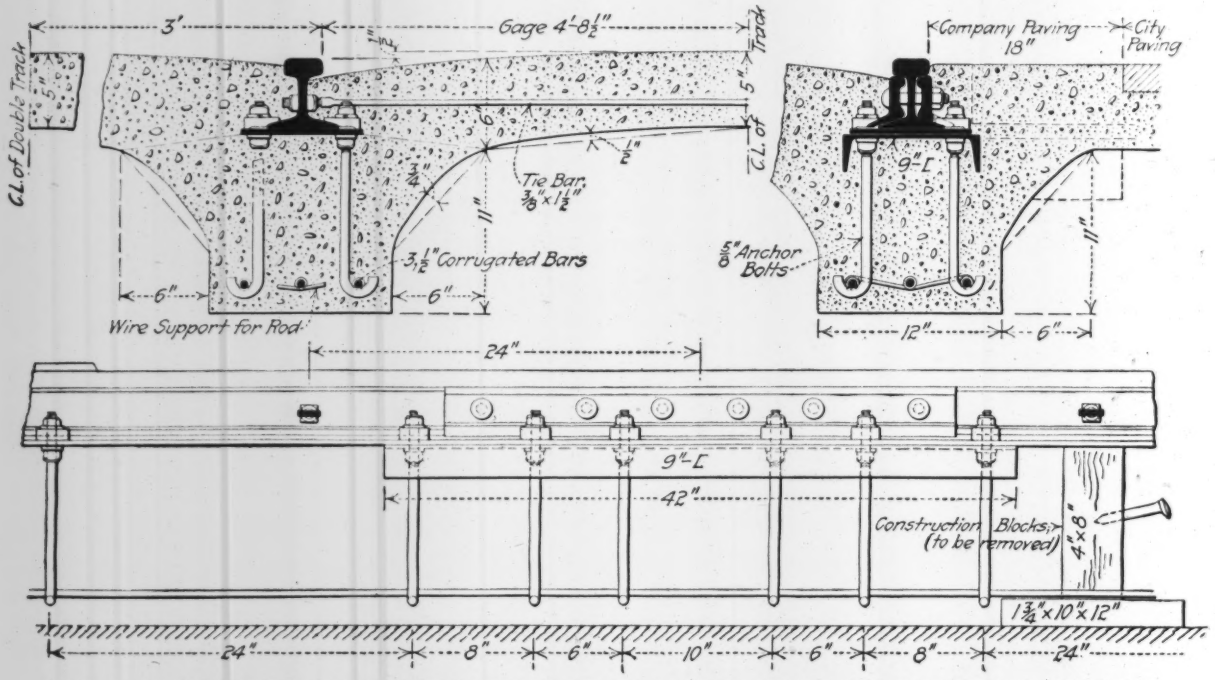


FIG. 1. CROSS-SECTION OF STREET-RAILWAY TRACK CONSTRUCTION WITH T-RAILS AND CONCRETE PAVING AT ANDERSON, N. C.

Another very common cause of failure of track pavement is impact at the joints. This may result from any or all of several causes, and when once it develops it is generally fatal to the pavement around it. We believe we can make a simple base-supporting splice which will overcome the causes of impact very largely and on the other hand will so distribute any possible impact as to render it harmless. Even patented joints in use now are dependent upon a number of factors for successful use, and all of them will fail if impact sets in.

The construction illustrated will be used immediately on about 6 mi. of track in Anderson and Greenville, S. C., and elsewhere, as may be necessary. Accurate

*Engineer, Southern Public Utilities Co., Charlotte, N. C.

cost records will be kept. It is believed that this type will be of special interest in view of the fact that whereas a few years ago paving was not required except in the centers of the larger towns, now railway companies are forced to pave tracks even in smaller towns and in all classes of streets, where falling revenues with light traffic do not justify high rails and expensive construction.

No patents have yet been granted, but an application is being prepared which will cover the principal features. We do not claim that this construction is new throughout, for we have gleaned several ideas. Many features, however, are entirely new and the arrangement as a whole is new.

Features of the Design

The special features of this type of construction may be stated as follows:

1. Use of low T-rail instead of high T-rail. With the latter rail (a) it is necessary often to buy more metal than is required to carry the traffic, in order to get paving depth; (b) the same tonnage costs about 30 per cent. more than standard rail because it is special; (c) the same tonnage gives less wear than the standard rail, because of the smaller amount of metal in the head of the high rail.

2. Continuous rolled-steel bearing plate. This plate, 3/8x8 in., affords great resistance to overturning, and distributes the stress over a width much greater than that of the rail base.

3. Strong and frequent anchorage of rail to plates embedded in the concrete. This is afforded by the long hook bolts, which also serve to hold the longitudinal reinforcing rods in the bottom of the beam during construction.

4. Continuous, reinforced-concrete girder under each rail. This girder is made of strong, rich concrete and is capable of taking our heaviest cars over short spans where wide trenches have sunk, or over longer stretches of poor soil, without destroying the structure.

5. Provision for shrinkage of the concrete. This is made by the use of jam nuts and wood washers under the base plates and high-tension split washers on top of the rail clips. The top nut will be drawn down until the lock washer is flat. If there be any shrinkage, the weight of the cars will cause the plate to sink down until the wooden washer is compressed and the load bears evenly on the concrete, when the lock washer above will open slightly and prevent any lost motion.

It is hard to see how any considerable amount of shrinkage can take place under the plates. If the center of the shrinkage be assumed as at the center of the 12-in. beam, therefore 6 in. under the plate, and the shrinkage as 0.08% (a liberal allowance), theoretically the relative motion between the plate and the rail will be only 0.0096 in. or less than 1-100 in. The washer used will take up 1/8 in. easily, and although we do not expect as much shrinkage as that, we can hardly believe it to be as computed, less than 1-100 in.

6. Elaborate treatment of the rail joints. The intention is to secure a perfect fit of the rail ends, so that there will be no initial pounding, and to make a structure so strong and stiff that it will not allow relative motion of the parts. The rail ends will ordinarily be finished by grinding; but in some cases where the track is laid in earth the rails have never closed the expansion joints, and the interurban cars have badly pounded the rail ends. In these cases the ends will be cut off with a power saw.

The rails will be laid close, no allowance being made for expansion, since the area of metal exposed to the sun will be small, and the concrete surrounding the rail will rapidly conduct the heat away. The holes in the rail are 1 in. in diameter. The bolts used will be 7/8 in. in diameter, of Mayari heat-treated chrome steel, with a very high elastic limit. The bolts are a very important part of the structure. The object in using these large bolts in the 70-lb. rails is to get great strength as well as to fill the holes in the rails to get a continuous structure. The splice bars are of standard angle section, with notches cut in the flange for the same kind of rail clips as are used elsewhere.

7. Increase of available conductor area. This may be secured by bonding the ends of the 3/8x8-in. base plates together, with occasional bonding to the rails. The rails, if well bonded, afford ample area for the current, but the bonding of the base plates would protect the structure against any electrolytic action (however unlikely). Although with good rail bonding this plate bonding would be superfluous, it would be a good investment as a protection against defective bonding if it prevented the loss of only about 1000 kw.-hr. annually per mile. We intend to experiment with this feature.

Advantages of This Construction

The advantages are nearly obvious and may be summed up under four heads:

1. Complete adaptability. The only articles not on the market as stock are the hook bolts and the wood washers. The construction is adaptable to any density or weight of traffic, conditions of soil, size of rail, etc., by modifications of beam, anchors, etc.

Where the rolling stock is exceedingly heavy and the schedules close and fast, we would use a deeper beam, properly reinforced, with larger anchor bolts and a 2x8-in. creosoted pine stringer with field notches in the sides for the anchor bolts to pass through. In such a case, we contemplate special provisions for the renewal of rails and stringers—matters which need not be entered into here. In general, we believe that a proper modification in the steel structure would be sufficient.

2. Permanence. This construction is believed to be as nearly permanent as a track structure can be built.

3. Comparatively low cost, $15,079 per mile of single track. This averages about $3000 per mile cheaper than ballasted high T-rail construction, which involves an excavation 18 in. deep, 9 ft. wide; 5-in. rolled ballast under ties and to tops of ties 2 ft. in middle of track; oak ties 6x8 in. by 8 ft., 30 in. c. to c.; 7-in. 80-lb. T-rail 60 feet

ESTIMATE OF COST PER MILE OF SINGLE TRACK (EXCLUSIVE OF BONDING) *

Excavation, 1160 cu.yd. at 50c	$580
Rails, 110 tons at $38	4,180
Splices, 9969 lb. at $2.10	209
Bolts, 1320 lb. at $0.0435	57
Lock washers, 1056 lb. at $0.01	11
Clips, 7300 lb. at $0.0235	171
Machine bolts, 3000 lb. at $0.012	36
Hook bolts, 4800 lb. at $0.035	168
Split washers, 7800 lb. at $2.65 per M	20
Base plates, 107,000 lb. at $1.68 per 100 lb	1,797
Corrugated bars*, 56,000 lb. at $1.665 per 100 lb	933
Channels, 8500 lb. at $1.68 per 100 lb	143
Tie-rods, 700 lb. at $0.16	112
Hauling steel on work car, 190 tons approximately at 50c	95
Assembling track, no tamping	500
Concrete, 1160 cu.yd., at $5.23	6,067
Total cost of materials and placing	$15,079

* Four bars in each girder, instead of three as shown by the drawing. Due to foundationd conitions.

long; concrete, 1 : 1½ : 3, from bottom of ties under rails to tops of paving.

4. Minimum maintenance and depreciation charges.

Concrete Paving and Foundation

Concrete Surface—Concrete was adopted because (a) the experience of ourselves and others has shown it to be a satisfactory wearing surface when the foundation is not broken up; (b) a concrete surface can be laid more cheaply with respect to material, and if monolithic with the base, more cheaply also with respect to labor, than almost any other suitable surface; (c) concrete is best adapted for use with low T-rail.

The wearing surface used heretofore has been a 2-in. course of cement and granite screenings mixed 1 : 1½, with screenings ranging from ⅜ in. to $\frac{1}{32}$ in. This is very satisfactory, but the screenings become expensive at times on account of the fact that no dust is allowed in them. We have not had many of the troubles supposed to be inherent in two-course pavement, but we have here adopted a coarse concrete top because it will be cheaper, and will wear as well if properly put down.

A mix of 1 : 1½ : 3 was chosen at first to make proportion of cement and sand the same as proportions of cement and screenings in our former top, and then because this mix seemed largely used elsewhere. But it is probable that we shall use 1 : 2 : 4 or even 1 : 2 : 4½ in case we get as low a percentage of voids in the stone as we expect. The sand will be, as nearly as possible, about half coarse and half fine, as this has been found to be the strongest mixture of sizes. The stone will be blue granite, from ¼ to 1 in., and we expect to get a low percentage of voids.

Method of Rolling the Concrete Surface

We expect to use hydrated lime to the extent of about 8% of cement used (proportioned by weight) to secure density and waterproofness. We plan to roll with a small cast hand-roller of sufficient weight, rather than to tamp; then to wood-float it, trowel it and score it into blocks 5x10 in. with staggered joints. We have two alternate treatments of the surface in mind; one is to scatter on the concrete a light course of screenings, trowel and score as before; the other is to scatter on the top a course of 2-in. stone after tamping or rolling with a gridiron surface, the stone being lightly rolled so as to bring flat faces up and make them flush with the mortar.

If the roller is made with blades 1¼ in. deep, 1 in. apart, it is believed that only ½- and ¼-in. stone will remain on top, with an excess of mortar in which the 2-in. stone will be bedded. This will be rolled with a plain roller to bring the flat sides up, and together with the small stone form a good wearing surface. These alternative methods will be tried, and perhaps adopted if found better than the plain concrete. Of course if 2-in. stone is put on the surface it cannot be blocked off.

Paving Base—This will be the same mix as the top, will be monolithic with it and also with the track foundation.

Track Foundation—This will consist of large reinforced-concrete girders under the rails, of the same mix as the top and paving base, reinforced with three or more corrugated bars lapped so as to be continuous.

Cross-Section—The track foundation and pavement, which are monolithic, take the form of an arch, the pavement in the middle of the track forming the flat crown and the girders under the rails forming the abutments. It was desired to make the entire structure effective; the girders, carrying the track loads, and the crown, upon which there is street traffic only, being proportioned for those loads.

The shape of the surface, which is crowned from beneath the rail heads and has no distinct groove, has been our standard for several years, both with concrete and brick pavements. It has been satisfactory both to us and to the citizens.

At 50-ft. intervals will be expansion joints not over ½ in. wide, 5 in. deep, filled with asphalt and stone dust. Midway between these will be contraction joints made by using a thin steel plate (greased), which is removed after the concrete has set. The joints are filled by pouring in hot asphalt.

Design of the Track Structure

Rail—We use the Am. S. C. E. 70-lb. T-rail section because it gives maximum wear on account of the center bearing and distribution of the metal; and further because it is the cheapest rail since it is a standard section and rolled by all mills.

Bearing Plate—A width of 8 in. was selected as about the maximum which might be used without isolating a cake of concrete above it; and because this width afforded about the right projection from the rail base for the bolts and clips. The thickness of the plate is greater than that found by static computations, but not too great when the shocks of our heaviest cars are considered.

Anchorage—It is contrary to facts to assume that the rail will lie flat on the girder, and therefore anchors spaced from 5 to 10 ft. apart are insufficient. The rail should have a uniform bearing and should be held uniformly on that bearing. This calls for anchors much closer together than is customary in this class of construction. We have generally anchored the rail every 2 ft., and closer at joints.

Tie Rods—We have adopted a ⅜x1½-in. flat tie rod, but have placed it only 1½ in. from the base of the rail, so as to have it as low in the paving as possible, to prevent cracking. Should cracking develop, we will use a strip of light wire mesh over the rods. We have held to tie rods, although with similar construction (Rinehardt system) in Berlin and elsewhere they have been found unnecessary.

Rail-Joint Reinforcing—Impact is responsible for the failure of joints in paved streets. It may be developed from the first because of uneven surfaces of the rail heads, or it may be developed later by pounding in consequence of broken wave motion. Where the support is yielding, there will be a concavity under the wheel, and where the anchorage of the rail is not frequent and powerful, there will be a convexity ahead of the wheel. The conditions necessary for transmission of wave motion (and load, of course) are that the splice bars shall be long enough, strong enough, not worn badly and tight-fitting. The wear usually takes place on the top of the bars.

The conditions favorable to failure resulting from improper fit of the bars are: Bolts overstrained when first put on; poor mechanical fit; movements of the rails because of expansion and contraction (allowed by the long holes in bars and large round holes in the rail); and badly worn condition of bars.

We will guard against overstraining the bolts by using large heat-treated steel bolts with strong washers; but we must depend upon the manufacturers for good initial fit. We will provide against temperature movements by having bolts fitting the holes in the rail tightly and butting the rail ends close together. We wished also to have the holes in half the bars made round, so that by putting all the nuts on one side of the rail we could have close-fitting bolts in the splices also; but the bars were punched before we decided on this. We do not know how better to prevent wear of the tops of the bars than to use higher carbon metal; this wear is a combination of compression of fibers and flow of metal. We planned to use the splice bars without the nearly horizontal leg, but the cost of rolling or of shearing after rolling was prohibitive.

We have met the requirements for an efficient joint as follows: (1) Rail heads will be ground, and in rails already battered the ends will be sawed off. (2) Looseness will be prevented by the use of closed joints, large high-tension tight-fitting splice bolts and strong anchorage of the track by means of anchor bolts. (3) A steel channel

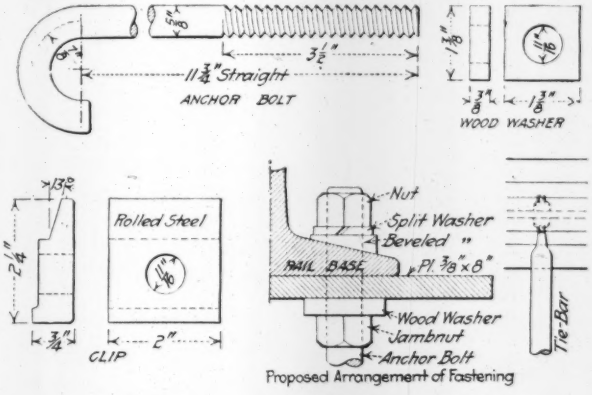


FIG. 2. DETAILS OF T-RAIL TRACK FOR STREET RAILWAY AT ANDERSON, N. C.

is provided to transmit flexure, this being anchored to the rail and plate over a considerable length so as to maintain the rail ends in the same plane. (4) The base plate and channel will distribute load and impact.

Reinforced-Concrete Track Girders

The ultimate support of the wheel loads is the earth, the bearing value of which is limited, variable and uncertain. Therefore pressure should be distributed over as large an area as possible. Under any circumstances there will be some deflection and some settlement. The former should be as small as possible and the latter should be even, so as not to disturb the pavement. Both these considerations point to the necessity for having beneath the rail a member capable of taking the entire wheel load and distributing it over the requisite area of earth. For this purpose we have adopted the reinforced-concrete girders.

There are two general methods which may be used in the design of the girder: One is to assume that the rail and the reinforcing rods form the chords of a built-up beam, and that the concrete and anchors transmit the shear only, the rail taking the compression instead of the concrete. This assumption involves another—namely, that the longitudinal shear will be transmitted from rail to plate, and thence to concrete, and there will be no slipping there. In order to be sure of securing this condition, it would be necessary to have bolts through the rail base (as shown in Fig. 2). With this construction a low T-rail can be used under all traffic, the minimum requirement being to use enough reinforcement to throw the neutral axis at or near the base of the rail, so that there will be no cracking of the concrete. The depth and reinforcement will vary with the loads.

The other method of design is to assume the load on the concrete beam as practically concentrated, and to place sufficient reinforcing in the bottom of the beam to distribute it over an ample area of earth.

Of the two schemes, the first is perhaps the better from a cost standpoint, generally speaking. But in our case we are using rails already on hand, and will use them with clips and reinforce for almost the entire load (with shock) concentrated. We believe that when rails are ordered from the mills, the cost of punching holes in the base of rail plus the cost of beveled washers would be less than the cost of the clips used on the edge of the rail, and the reinforcing would be more efficient and cheaper. We have just ordered a hydraulic punch, which should enable us to punch holes in the field rather cheaply, and we will see what can be done in this way. The base plates under the rails are counted on only to widen the bearing area on the concrete.

Answers to Criticisms of the Design

The criticisms which have been made of the above system of track construction may be considered as follows:

1. The track will be too rigid. We believe a really rigid track can be built and be successful, the vibration being taken up in the cars. We know of tracks in this country and abroad which are similar to this and give no trouble due to rigidity.

2. Concrete is not suitable for a wearing surface. Our whole experience has been a contradiction of this, even though some of our own work is not satisfactory.

3. The expansion joints in the concrete will spall and disintegrate. We have never had trouble from our expansion joints. We originally used for edge protection a set of plates, which were anchored into the concrete by bolts; but this was very troublesome and somewhat expensive, so we have since been using the joint described in the specifications. The most important things about expansion joints are to get them narrow and to thoroughly compact the sides with an edger.

We also use an edger against forms for the edge of our pavement next to the city pavement, and have no trouble here either; although we formerly had this edge sloping outward upon the theory that that would prevent spalling, the most noticeable effect of this slope was to allow the asphalt to crawl up it under the ironing effect of vehicular traffic, ultimately causing a rut there, so we have since made the edge vertical. The contraction joint we have adopted because we have found that where the expansion sections were laid 50 ft. apart a contraction crack nearly always formed exactly midway.

4. Underdrainage. We have no provision for underdrainage and do not believe it necessary in our conditions.

5. Electrolysis. The possibility of electrolytic action upon the steel below the rail is very remote, and may be obviated at little cost.

6. Regaging or changing rail or grades. When the rail needs regaging or renewing probably we will wish to

double-track the line. The grades are set by the city, and there is only the remotest possibility of having to change them. Provision could be made for regaging or renewing rail by using long holes in the plates (for adjustment), by separating the foundations and top slab by a layer of heavy paper, and by tipping the tops of the anchor bolts with tar, so that they would not rust.

7. Shattering of concrete. It has been suggested that the concrete around the rail may be shattered by vibration or by ice under the rail and plate. The vibration of the rail will be so limited with anchorages 2 ft. apart that it will be incapable of causing impact. Little or no water can find its way under the rail, but in a colder climate tar or asphalt might be poured along the edge of the rail.

8. Special work and curves. Our special work will be laid on steel or wood ties on a concrete base. For curves, the plates will bend the same as the rail. Steel-weld compromise rails will be used instead of compromise joints.

Construction Methods

The water is taken from hydrants along the curb, and no charge made against the contractor for it, as the company owns the water-works system.

The cement is furnished by the company in warehouse or in cars in railway yards, and is hauled to the job by the contractor and protected by him. As the inspector on the job receipts for the cement delivered on the job and shows on his report the disposal of it, we know just what mixture we are getting. By thorough experiment we will find the length of track which should be built with a certain amount of cement, so that we will have both a check on the grading and on the use of the cement.

The stone is delivered by the company on the streets to be paved, at the intersections. We have several cars built for this purpose having an A-shaped bottom and slide doors which trip by a hand lever operated from the cab. The load can be dumped in six parts, as the length of the car is divided into three compartments, and each compartment dumps half on either side. The load dumps well clear of the rails.

The rails are in general those at present in service; and they are removed by the combined forces of the company and the contractor. This is done by jacking up the rails every 15 ft. and knocking off the old ties with sledges. The specifications state that we will take up the rail and the contractor will take up the ties. Contractors generally are loath to participate in this method, as they seem to feel that advantage is being taken of them, although it is more to their advantage than to ours.

The excavation is done mostly by pick and shovel, and the hauling by wagons. Tamping is used, as rolling is not practicable here. When the excavation is ready the company assembles the track and puts it to line and grade. No attempt is made to have the track to final line and grade for more than a block ahead of the concrete, as temperature changes and other disturbances would destroy it. Of course, the track will be fixed longitudinally, as one end will be completed and fast. The track is supported vertically during construction by bearing blocks under the anchor bolts (which are rigid on account of the jam nut under the bearing plate). The track is lined by staking from the sides.

The concreting was intended originally to be done entirely from set-ups at the intersections, using plank runways in center of the track and 6-ft. hand carts for hauling the concrete. The placing of the concrete was to begin at the middle of the block, and back up toward the mixer as the work proceeded, the carts returning on the roadway beside the track. It was believed that these carts would be very economical for this work. It was afterward decided to spout the concrete into place, which was done with very good results. A 2½-in. top surface is made with concrete 1 : 1¾ : 3½, using ⅛- to ⅝-in. stone, which gives a surface that can be finished as smooth as a sidewalk. This is quite satisfactory, and although the concrete is put on in two courses it forms in effect one solid mass.

The concrete is placed and finished as specified elsewhere. The scoring board used to block off the surface is made of heavy timbers, having a crown slightly flatter than the finished pavement. This crown is sawed out of the thickness of the timbers. On the bottom or working side there are V-shaped oak strips put on in a staggered arrangement to follow the lines of 5x10-in. joint blocks. This board has a length equal to the width between rails and a width of 20 in. or four courses of blocks.

The strip is left off from the last block edge on the front side and when the board is moved forward the last strip on the rear side is set across the ends of the short joints of the last course scored. This is done because it was found that when the outer edge of the last course was printed, and the men attempted to set the board for the next width, they lost time getting the oak strips to register in the last one of the last width, and often made a double joint there, whereas when the short joints of that course only are printed before taking up the board, the rear strip can be set across their ends at the next setting without trouble.

These boards have scored over 100,000 sq.yd. of paving for us and have been perfectly satisfactory. They cost about $5 each, will print about 10,000 sq.yd. (with frequently renewed oak strips), and would last indefinitely except that the men in using them tamp on them with a pick or other heavy object. Two or three light blows suffice. They are operated by the finisher and water-boy or one of the common laborers, and this scoring really adds practically nothing to finishing cost, because it goes very rapidly and the finisher has ample time from his floating to do it.

Separate boards with no crown can be used for the flat paving outside the tracks, and this method is better than having that part done by a long single board. We have used for the space between double tracks a longer board similar to the one used in the tracks, but with the end bearings arranged to allow the printing to be done ¼ in. below the rail instead of 1¼ in. These boards are kept greased. They have handles made of old rubber hose.

Specifications for Construction Work

The specifications include the following sections governing the construction work:

Outline of Work—(a) The company will remove the old rail. (b) The contractor will remove the old ties to the edge of the street; they are not to be sold. (c) The contractor will excavate to cross-section shown on plan and to grade set by the city engineer or the engineer of the company, and will tamp the subgrade to the satisfaction of the engineer. (d) The company will build track ready for the concreting. (e) The contractor will place concrete and protect it until acceptance.

Excavation—Earth must not be disturbed below subgrade. Where filling is necessary it shall be done with approved material in 5-in. layers and thoroughly tamped. Waste excavated material shall be the property of the company, to be

hauled by the contractor to any point designated, not over 2000 ft. on good roads.

Concrete—To be composed of 1 part cement, 2 parts sand or screenings and 4 parts crushed stone (size passing 1-in. ring and retained on ¼-in. ring), and hydrated lime 5% of weight of cement. To be laid of a consistency satisfactory to the engineer, thoroughly tamped and floated with wooden float, troweled if required, and blocked off if required by the city. The scoring to be shallow grooves made with a scoring board.

Joints in Paving—Contraction joints to be provided every 50 ft., to be not over ½ in. wide, 5 in. deep, filled with asphalt and stone dust. These are to be made by using weather-boarding, dressed on both sides and greased, and withdrawing the board after concrete sets and filling as noted before. Midway between these joints shall be contraction joints made by using a thin steel plate (greased) withdrawing after concrete sets, and pouring with asphalt. Both these joints must be thoroughly compacted along their edges by using edgers of small radius.

Protection of Work—In hot weather the pavement shall be kept wet for at least three days (sometimes longer) by the liberal use of water sprinkled upon it. The company furnishes the water. When required by the engineer 3 in. of sand shall be sprinkled upon the pavement for the purpose of holding the moisture, and keeping the pavement cool. In cold weather, if the thermometer is below 40° at 4:30 p.m., and is going down, all placing of concrete must be stopped and that part which is already laid must be finished as soon as possible. If the thermometer is going up at 4:30 p.m., work may be continued until 6 p.m. When required by the engineer the work must be covered with tar-paper and 2 in. of horse manure. Other means may be used if preferred by the contractor.

Car-Transfer Ferry on the Ohio; C., B. & Q. R.R.

In order to develop a new rail route from the Northwestern States to the Gulf, the Chicago, Burlington & Quincy R.R. is building a line 13 mi. in length from its present terminal at Metropolis, Ill., to connect with the Nashville, Chattanooga & St. Louis Ry. at Paducah, Ky. The principal engineering feature of this line will be the great double-track bridge across the Ohio River, but this will not be completed for some time.

To provide immediate communication across the river, the new railway has been extended down the bank on each side of the river, and cars will be ferried across on transfer boats. These are double-track deck scows, accommodating ten freight cars on each track. They will be handled by tow-boats. The distance between landings is about one mile.

At each landing an incline is laid to about low-water line, and on this rides a cradle, which is moved up or down the incline to keep its rails at the same height above the varying level of the water. The cradle is shifted as required by a cable attached to a locomotive and passed around a hitching pulley on the cradle frame. The incline has a descending grade of 3 per cent. for a length of about 2000 ft. The track on the cradle is level, with a short 4 per cent. grade rising from the incline track to the cradle track.

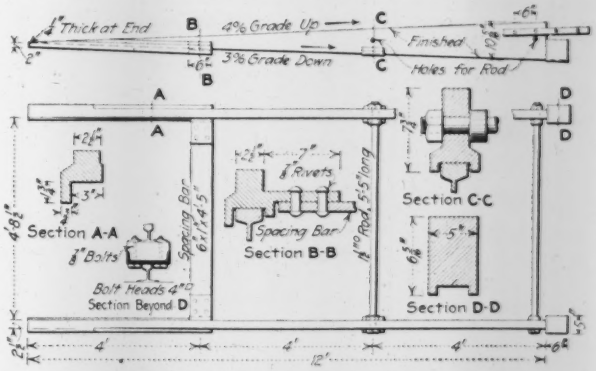


FIG. 2. FEATHER-RAIL CONNECTION BETWEEN TRACK ON INCLINE AND TRACK ON CRADLE

The incline is double-track, with two cradles, one for each track on the boat, but the cradles are separate and are operated independently. The river end of the incline is a double-track timber trestle, with five-pile bents 13 ft. c. to c. under each track and two lines of 8x16-in. string-

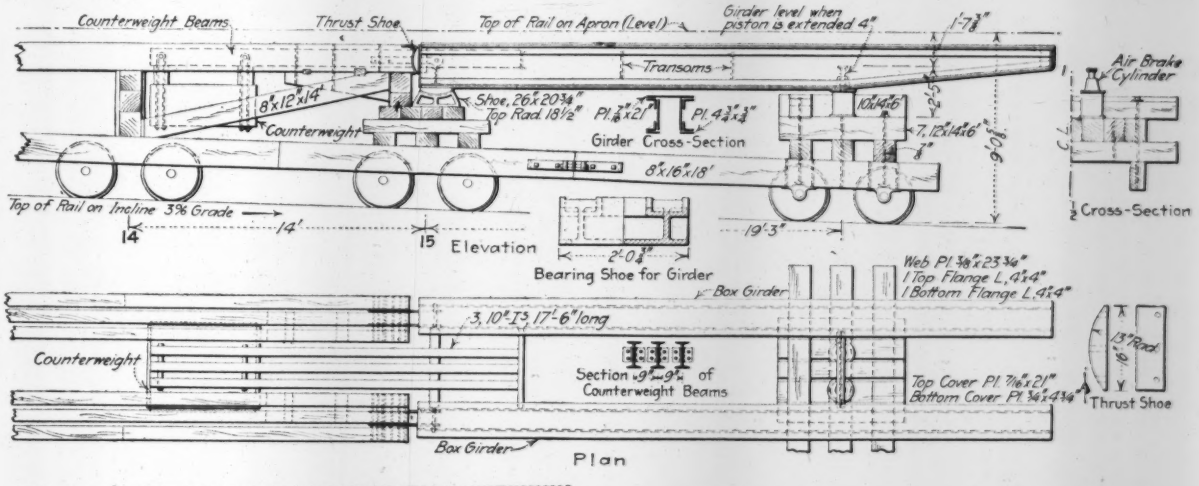
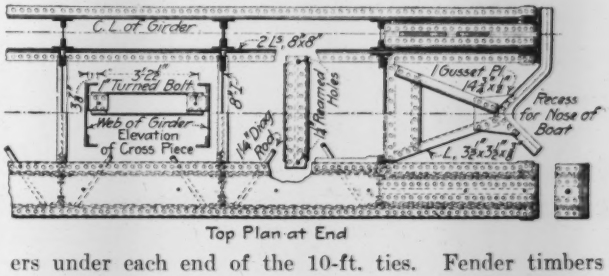


FIG. 1. ADJUSTABLE APRON CONNECTION BETWEEN CRADLE AND CAR-TRANSFER BOAT



ers under each end of the 10-ft. ties. Fender timbers are laid upon the outer ends of the caps. The tracks are 12 ft. c. to c.

The general construction of the cradle is shown in Fig. 3. It is 240 ft. long. Its deck consists of two pairs

of 8x16-in. stringers upon which are laid the 10-ft. ties. At the land end, where the height is low, the stringers rest directly upon axles arranged in pairs. As the height above the incline increases they are supported by blocking or cross-timbers on two lines of substringers, which are mounted on the axles, as shown. The wheels are mainly 33-in. car wheels. As the joints of the stringers are in tension when the cradle is hauled up the incline, they are spliced by horizontal bolts passed through the outstanding flanges of L-shaped straps spiked to the sides of the timbers. These connections also give vertical flexibility to allow for irregularities in track surface.

Land and River Connections of Cradle

At the land end of the cradle is a pair of 12-ft. feather rails to connect the track on the incline with that on the cradle. This connection is shown in Fig. 2. The feather rails are steel castings 12 ft. long, grooved on the under side to ride on the incline rail, while the upper surface forms a running head for the wheels. At the toe, where the wheels are engaged, the thickness of the feather rail is only ¼ in. At the heel there is a splice connection to the track rail on the cradle.

The river end of the upper deck of the cradle is an adjustable apron 30 ft. long, supported by cross-timbers on the substringers. This is shown in Fig. 1. It consists of a pair of heavy box-girders, connected by crosspieces and diagonal lateral rods. The I-beam crosspieces are not connected rigidly to the girder webs, but are secured by horizontal pins through angle brackets on the webs. This allows for variations in level of the opposite rails of the incline track, the girders being free to rise and fall independently in a vertical plane, while with rigid riveted connections severe twisting stresses would be set up.

The apron is supported at the heel and one intermediate point, and its outer end is cantilevered beyond the latter. The outer end is raised and lowered as required to compensate for slight changes in level of the tracks on the cradle and the boat and to bring these rails into exact position. For this purpose its outer support carries a pair of air-brake cylinders, with piping led along the cradle and fitted with hose so that it can be connected to the brake system of the engine handling the train. To balance the apron it is fitted with an extension arm consisting of three 10-in. I-beams having a counterweight box suspended from their ends.

Vertical and lateral movements of the apron are provided for by a hemispherical bearing under the heel of each girder, and a similar bearing or thrust shoe at its end, butting against the end frame of the cradle. The outer end of the apron is heavily built and braced to withstand blows and has a recessed end frame to receive the V-shaped nose on the end of the boat, thus automatically centering the tracks. Portable rail stops which slide on the rails are used to hold the cradle in position on the incline track, and also to hold the train on the cradle while making the rail-end adjustments of apron to boat.

The new railway is being built under the name of the Paducah & Illinois R.R. The incline on the Illinois side of the river was built and is owned by the Chicago, Burlington & Quincy, and that on the Kentucky side by the Nashville, Chattanooga & St. Louis, of which Hunter McDonald is Chief Engineer. The Chief Engineer of the Paducah & Illinois is C. H. Cartlidge, Bridge Engineer of the Chicago, Burlington & Quincy.

Federal and State Co-operation in Water-Power Control

By Leonard Lundgren*

Much has been said and written along theoretical lines about the dual control of water powers in the United States by the Federal Government and the Sovereign States, control by the former arising from the ownership of public lands and by the latter from state laws on the appropriation of water. Many writers have attempted to

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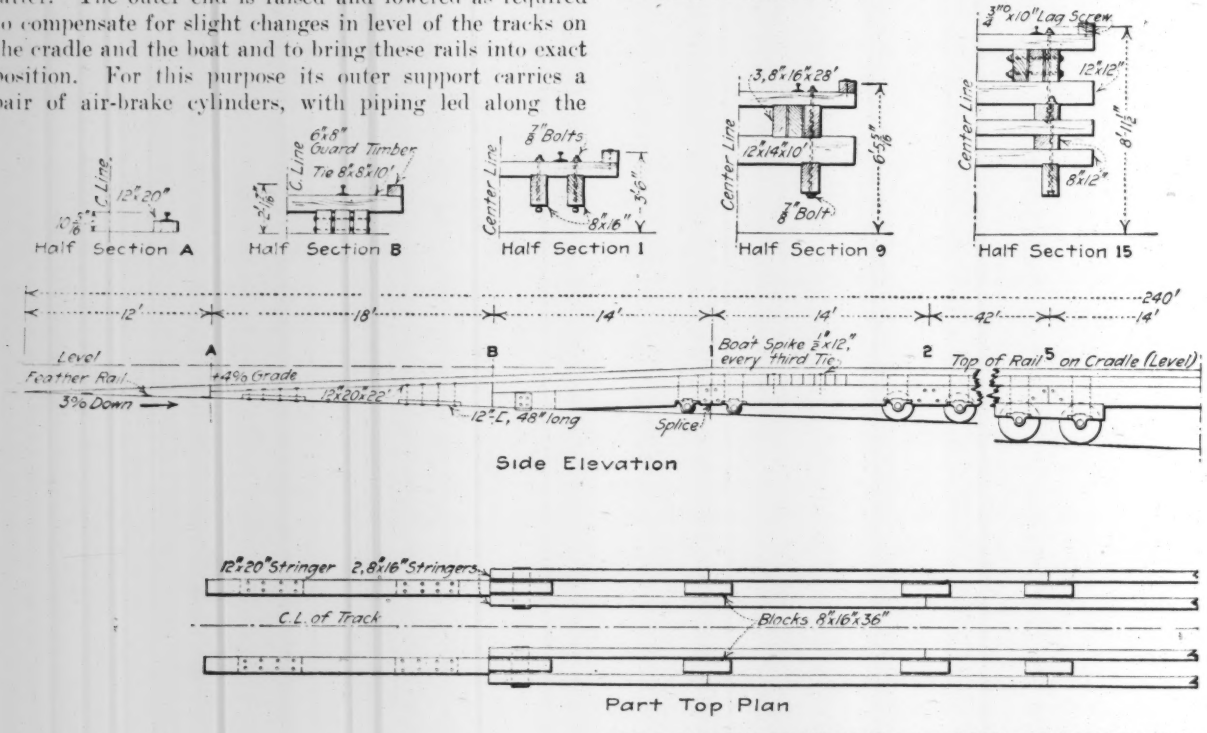

FIG. 3. CRADLE ON INCLINE OF CAR-TRANSFER FERRY ON

point out that such dual control is incompatible with the industrial development of the country and actually hinders its growth. In practice, however, the Federal Government works in the closest harmony with the State. The regulations of the Secretary of Agriculture, effective Feb. 1, 1915, contain the following:

> Wherever the approval of a state administrative official, board or commission is a condition precedent to the right either to take and use water for power purposes or to engage in the business of the generation, transmission or distribution of power, certified evidence of such approval must be filed . . before a final permit will be issued. Formal notification by such official, board or commission that the water right has been canceled or that the permission to engage in the power business withdrawn, will be deemed sufficient grounds for the revocation of the permit.

These or similar requirements have been in force in the regulations of the Departments of the Interior and of Agriculture for the last five years. During this period no person has secured a permit to construct a water-power plant on public lands without first securing a water right from the state.

Coöperation with State of California

A year ago, in order to facilitate the approval of applications for water power both by the state and by the Federal Government, a coöperative agreement was made between the Secretary of Agriculture, Hon. G. F. Houston, and the State Water Commission of California, of which Prof. Charles D. Marx, President of the American Society of Civil Engineers, is Chairman.

This agreement provides that whenever an application for a permit for a water-power site is filed with the District Forester of San Francisco, notice of the application will be sent to the State Water Commission. Whenever an application is made to the State Water Commission for a permit to appropriate water, if the use of such water will in any way make necessary the occupancy of any national forest land, the State Water Commission will give immediate notice to the District Forester at San Francisco. Further clauses of the agreement provide in substance that neither the State Water Commission nor the representatives of the Federal Forest Department will issue permits to water users until both authorities have given final approval to the application.

In accordance with this agreement the Secretary of Agriculture a few months ago refused certain rights-of-way in the Inyo National Forest to a company, as its previous application for the privilege of using the water of certain creeks had been rejected by the State Water-Supply Commission on the ground that the public interest so demanded. The company argued against this decision on the ground that the streams proposed to be appropriated were located entirely within the National Forest reserves and that the state authorities, therefore, had no voice in the matter. The Secretary of Agriculture in refusing to reconsider his decision said:

> It is believed that better results can be secured under existing conditions by coöperative action between the state and Federal authorities than by any insistence upon strict legal rights on behalf of either.

Another coöperative agreement has been made between the Department of Agriculture and the State of Oregon, represented by the State Engineer. This is framed on lines similar to those of the agreement with the State of California and provides that the District Forester at Portland and the State Engineer will each furnish the other with data and coöperate while acting upon applications for power permits on National Forest lands. This agreement was consummated in May, 1915.

It is anticipated that other states having laws which permit coöperation as outlined above will see the advantages that accrue and will accordingly enter into similar agreements.

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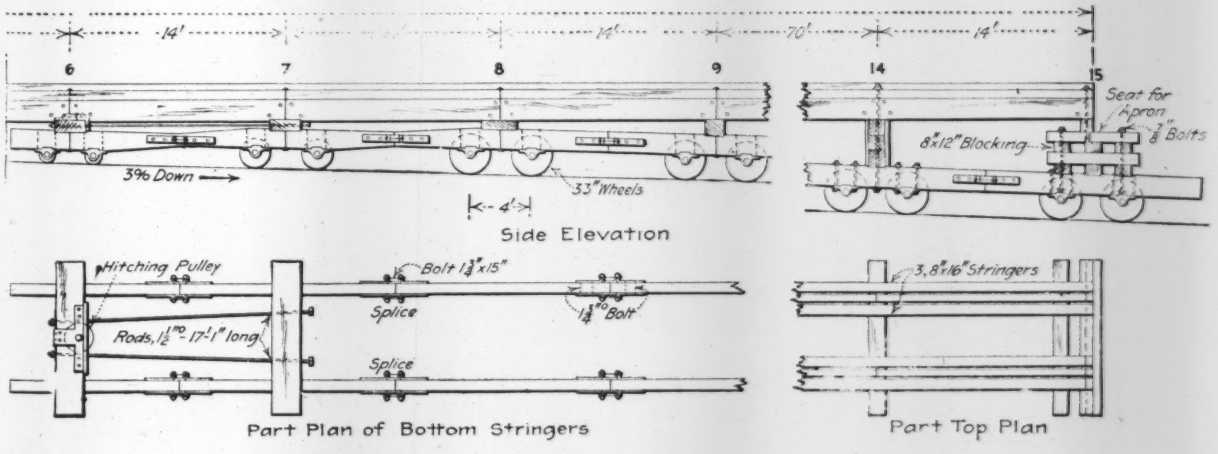
Lump-Sum Allowances for Extra Work were recently the subject of a dispute among the public authorities of New York City. Contracts let by the Public Service Commission for subway or other rapid-transit work require to be consented to by the Board of Estimate, which makes the appropriation to pay for the contract. Recently when several contracts awarded by the commission came before the board for appropriations, the board made the appropriation conditional on the elimination of a clause in the contract authorizing the chief engineer of the commission to fix either unit prices or a lump sum for incidental or extra work as it arose. The prior arrangement for extra work had been cost plus 10 per cent. This arrangement led to excessive supervision and accounting, which is avoided by using the lump-sum or the unit-price method of payment. For some time past the commission's contracts have included a clause making the latter methods optional as alternatives to the percentage method, and the board has hitherto approved such contracts. The board's conditional appropriation formed the subject of a court action by the bidder to whom a contract had been awarded for mandamus to require the board to give its consent and make the appropriation without qualification. The mandamus was issued by the court, and the board then consented to the contract and made the appropriation without condition. No appeal to a higher court was taken, because the board did not want to delay subway construction work; but it has made the statement that it does not accept the view taken by the judge who issued the mandamus and will carry the matter before a higher court on a subsequent occasion.



THE OHIO RIVER: CHICAGO, BURLINGTON & QUINCY R.R.

Field and Office

Lap-Bolted Crossbracing in Wide and Deep Cut

Bolted continuous crossbracing of subway excavation is employed by the Cranford Co. on sections 1 and 1A of the Flatbush Ave. subway, in Brooklyn, New York for diverging subway tracks on three double-track levels. In the upper part the bents are spaced 10 ft., in the lower part 5 ft. c. to c. The bents of the lower portion of this cut are not in the same vertical plane as the upper bents because of interference of steelwork; longitudinal timbers of the same lapped construction as the cross-struts

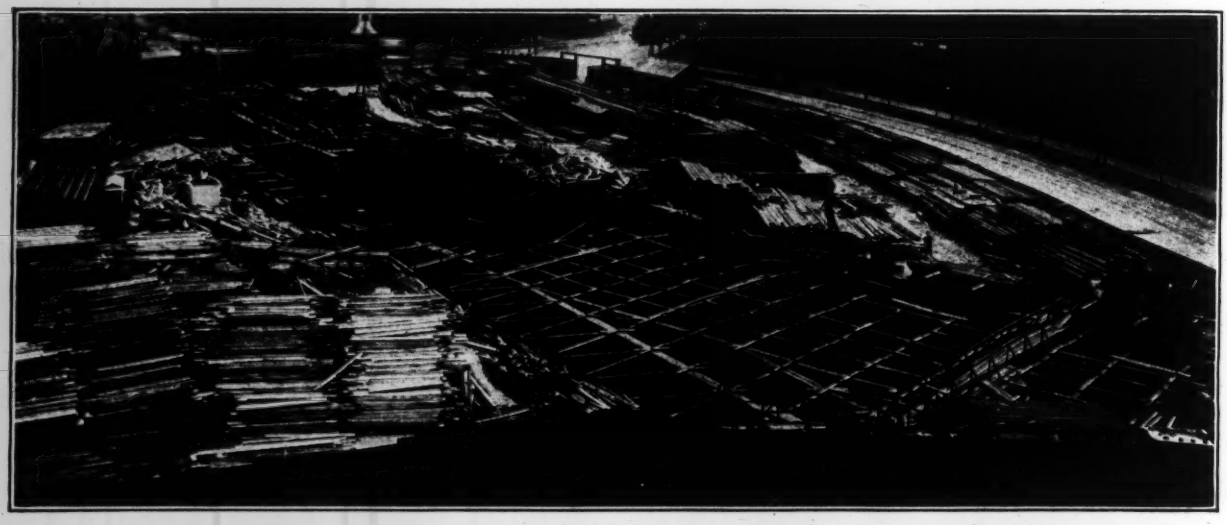


FIG. 1. GENERAL VIEW OF TOP OF DEEP OPEN CUT AT PROSPECT PARK PLAZA, BROOKLYN

City. Each crossbrace is built up of 6x12's, 16 ft. long, lapped 8 ft. and bolted together, forming a continuous 12x12. The bolt holes are located by templet, so that they will coincide, no matter which ends are lapped. This means rapid timbering and avoidance of waste. The crossbraces are posted and spread as shown in Fig. 2.

The illustrations show the timbering at Prospect Park Plaza, where the excavation reaches a maximum width of 100 ft. and a greatest depth of 82 ft., providing room

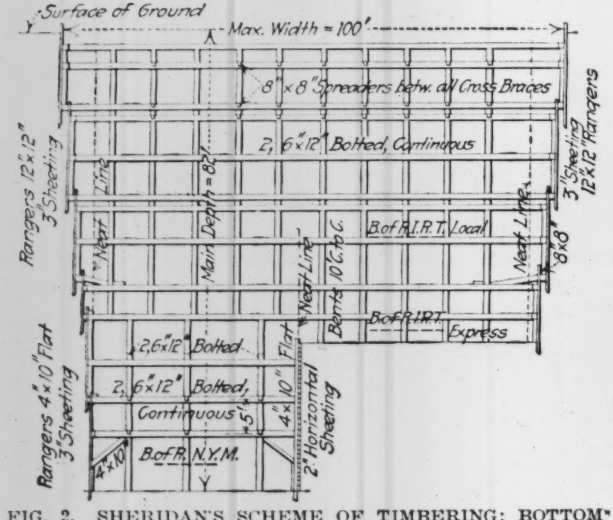


FIG. 2. SHERIDAN'S SCHEME OF TIMBERING; BOTTOM OF 80-FT. CUT

are used at the top of the offsetting to bridge. Elsewhere on the line the bent spacing is 10 ft.

John C. Sheridan, Chief Engineer for the contractor, devised the bolted timbering.

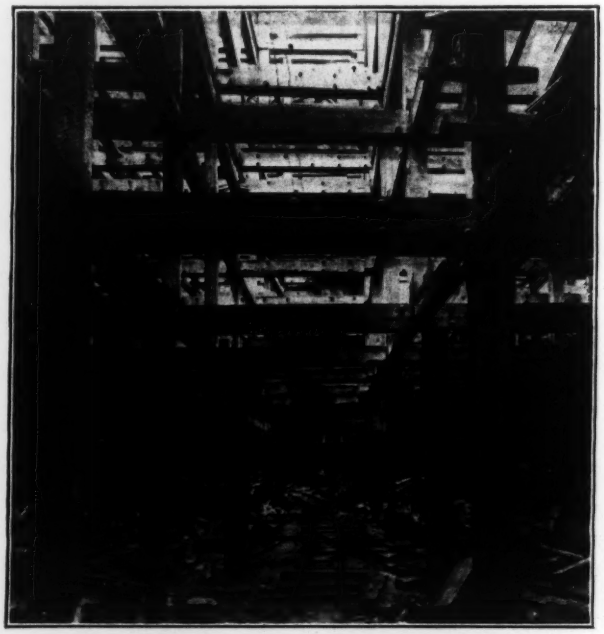
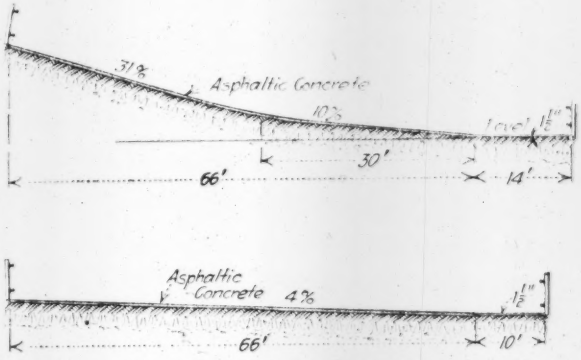


FIG. 3. TIMBERING FOR THE DEEP OPEN CUT

Adapting an Old Racetrack to Automobile Racing

A one-time famous horse-racing track at Narragansett Park, Cranston, near Providence, R. I., has recently been converted into an automobile racetrack by banking the curves and covering the trackway with an asphaltic-concrete pavement. The track is owned by Frederick E. Perkins, President of the Narragansett Park Speedway, Inc., who has personally planned and supervised all the construction work—with no little pride that he has done so without the assistance of an engineer.

The old horse-racing track was the usual one-mile oval consisting of two quarter-mile straightaways and two quarter-mile half-circle arcs of 420 ft. radius. The track surface was hard-packed loam overlying gravel, which is only one or two feet below surface over the whole meadow containing the track. This gives good natural subdrainage, so that the only additional provision for drainage considered necessary was the sinking of shallow pits, or sumps, at intervals around the inner edge of the



FIGS. 1 AND 2. CROSS-SECTIONS OF RACETRACK ON CURVE AND ON TANGENT

track. These are lined with dry stone walls and drain into the subsoil gravel. They are covered with substantial timbers.

The surface of the old track was thoroughly rolled with a 10-ton steam roller. On the curves the roadbed had previously been banked to a maximum of about 10 ft., the earth being placed in thin layers and allowed to settle for two or three years before the pavement was constructed. On top of the compacted surface of the old track a 4½-in. asphaltic-concrete pavement was laid in two courses, the bottom course of 3 in. being mixed to conform approximately to the well-known Topeka specifications, while the top course is practically a sheet-

FIG. 3. NARRAGANSETT ASPHALT MOTOR RACETRACK

FIG. 4. TANGENT ON MOTOR RACETRACK

asphalt mixture. The pavement is 66 ft. wide, not including the 10-ft. to 14-ft. apron inside the racing line; the total paved width thus is 76 to 80 ft.

The alignment of the old track was not materially changed. The measured one-mile racing line is from 10 (on tangents) to 14 ft. (center of curve) inside the inner edge of the pavement aprons. There are no easement curves between the tangents and the curves, as this would have required a redesign of the old track. An approximate cross-section of the curves is shown in Fig. 1. To attain the maximum superelevation of about 10 ft., the P.C. of the curve of the outside edge of

FIG. 5. CONSTRUCTION PLANT, NARRAGANSETT PARK AUTOMOBILE RACETRACK, CRANSTON, R. I.

FIG. 6. ROLLING ACROSS THE TRACK ON A 31% GRADE WITH SPECIAL STEAM ROLLERS

the track is placed at half the full superelevation, which is attained at a point 100 ft. beyond the P.C. From the P.C. to the level of the straightaway 150 ft. intervenes. Fig. 2 is a cross-section on the straightaway. The dished surface on the curves was obtained by eye, no templets being used.

For use in building the pavement, Mr. Perkins purchased one of the largest-size Cummer portable asphalt plants, a 10-ton 3-wheel steam roller, two 6½-ton tandem steam rollers, crushers, screens and bins and all other necessary paving equipment. He hired his own employees and personally superintended the work. Local stone and gravel were largely used, although imported sand and traprock were used to some extent. Work was begun in April and the pavement was completed in July at an approximate cost of $200,000. The tandem rollers had to be especially designed and built (Buffalo Steam Roller Co.) to permit their rolling the track banking, the upper half of which is on about a 31 per cent. grade. The difference between these rollers and the standard Buffalo-Pitts tandem rollers is said to be not only in the gear ratios, but in the boiler, which is designed for a higher pressure than standard.

Both edges of the track are lined with substantial posts spaced 3 ft. c. to c., to which are spiked two rows of 25-lb. steel railway rails. This railing is intended to be strong enough to deflect a runaway car back upon the track.

Inspection and Maintenance of Highway Bridges

In 1912 the state legislature of Rhode Island passed a law which put all bridges and culverts on roads which had in any way been improved by the state in the hands of the state highway department for maintenance and repair. In this way the perpetual care of about 156 bridges of various types was suddenly thrust upon a small engineering staff already with plenty of work to do. The bridges had been built at various times by the different county, town and city authorities and in many cases no record plans were available for filing with the state highway department.

To become better acquainted with the details of their legacy the following scheme was devised by the highway department engineers. Each bridge was inspected and measured by an engineer, and notes were made under the following heads: Name, location, type, causeway, substructure; abutments, piers, piling, wing walls, superstructure; trusses, lateral systems, bearing on abutments, floor-beams, stringers, roadway, sidewalks, railing, paint; general remarks; recommendations; notes. Two photographs, side and end elevations, were taken of each bridge with a 3A Kodak. All this was accomplished by one man in about 30 days.

From the inspection report, index cards 4x6 in. (Fig. 1) were compiled giving all the essential descriptive data on each bridge. In the filing number the first letter of the name of the county in which the bridge is located is used, together with the numerals of a serial number which runs from 1 to 156 for the entire state. A road map with the numbers of the bridges lettered on at the bridge site furnishes a ready means of locating any bridge. With the first a second 4x6 card is kept, carrying a record of the

B-11

HAMILTON AVE. BRIDGE

Location ..... Wickford (Boston Neck Road)
Type ..... Pratt Steel Truss—pin-connected
No. of Spans 1
Date Built ..... Built by ..... Town
Overall Length ..... 104 ft. Width ..... 33 ft. T. W. ..... 20 ft.
Clear Span ..... 101 ft. Causeways .....
Headroom ..... 2¼ ft. Headwalls .....
Bridges ..... Fieldbook No. 213 Plans P11
Reports and Data
Road F. B. No. 417 Sta. 950 N. K. 1908, Sec. 1
Plans

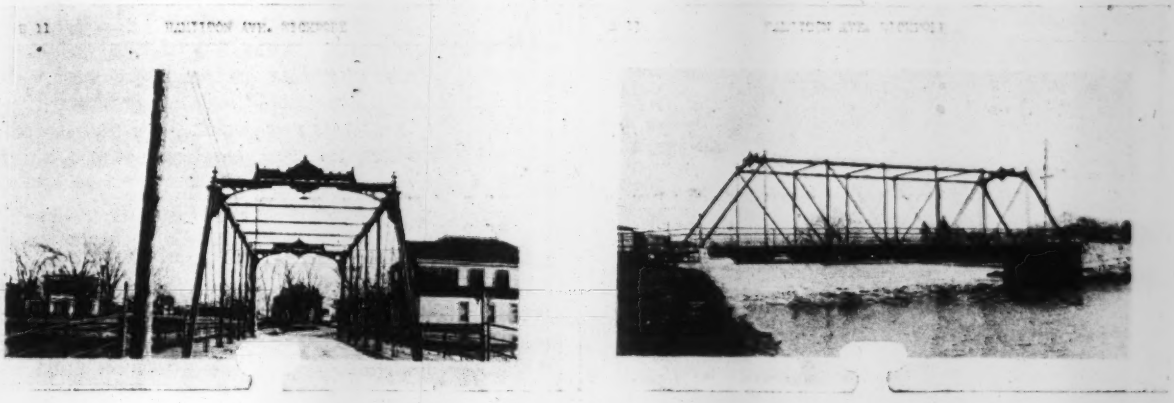
FIG. 1. RECORD CARD OF BRIDGE DATA; RHODE ISLAND STATE HIGHWAY DEPARTMENT

B-11

HAMILTON AVE. BRIDGE—MAINTENANCE

1912 Lumber and repairs	$126.95	
Painting	273.74	$400.69
1914 General repairs to sidewalk	11.82	$412.51

FIG. 2. RECORD CARD OF BRIDGE MAINTENANCE; RHODE ISLAND STATE HIGHWAY DEPARTMENT



FIGS. 3 AND 4. PHOTOGRAPHIC RECORD OF STATE HIGHWAY BRIDGES, RHODE ISLAND

repairs to each bridge (Fig. 2). The two 3¼x5½-in. photographs are mounted on 4x6-in. index cards (Figs. 4 and 5) and filed with the cards shown in Figs. 1 and 2.

As fast as they can be prepared, record plans of all the bridges are made from the field measurements. However, it is stated that the index cards and photographs afford a quick acquaintance with all the essential details of each bridge and its surroundings and have greatly facilitated the scheme for maintenance and repairs.

When repairs are made the foreman or assistant engineer in charge fills out weekly reports, 8½x11 in., which give the cost of labor and materials (differentiated). These are filed in the highway department office in a loose-leaf binder, under the bridge number, and the annual summaries only are transferred to the index card. In the same binder are kept the originals of the inspection reports.

Besides the file of cards of bridge descriptions and repairs, which are arranged consecutively by number, a separate card file is kept, arranged by names of towns alphabetically, under the name of each town being a list of the bridges in the town and their numbers. Another card file is kept of the bridge material on hand at different points.

The Chief Engineer of the Rhode Island State Board of Public Roads is Irving W. Patterson and the Assistant Engineer in charge of bridge inspection is J. V. Keily.

Organization for Bridge Work by Day Labor, St. Louis

The adoption of the day-labor system for the construction of the east, or Illinois, approach to the new Municipal Bridge over the Mississippi River at St. Louis, Mo., was noted in our issue of May 13, 1915, and the organization under this system is shown by the accompanying drawing. Clinton H. Fisk is Chief Engineer.

The railway approach will be 2.3 mi. long, and the highway approach 0.7 mi. The structure will include 24,000 tons of steel and 35,000 cu.yd. of concrete. Boller, Hodge & Baird, of New York, are the consulting engineers; Brenneke & Fay, of St. Louis, act as the resident engineers.

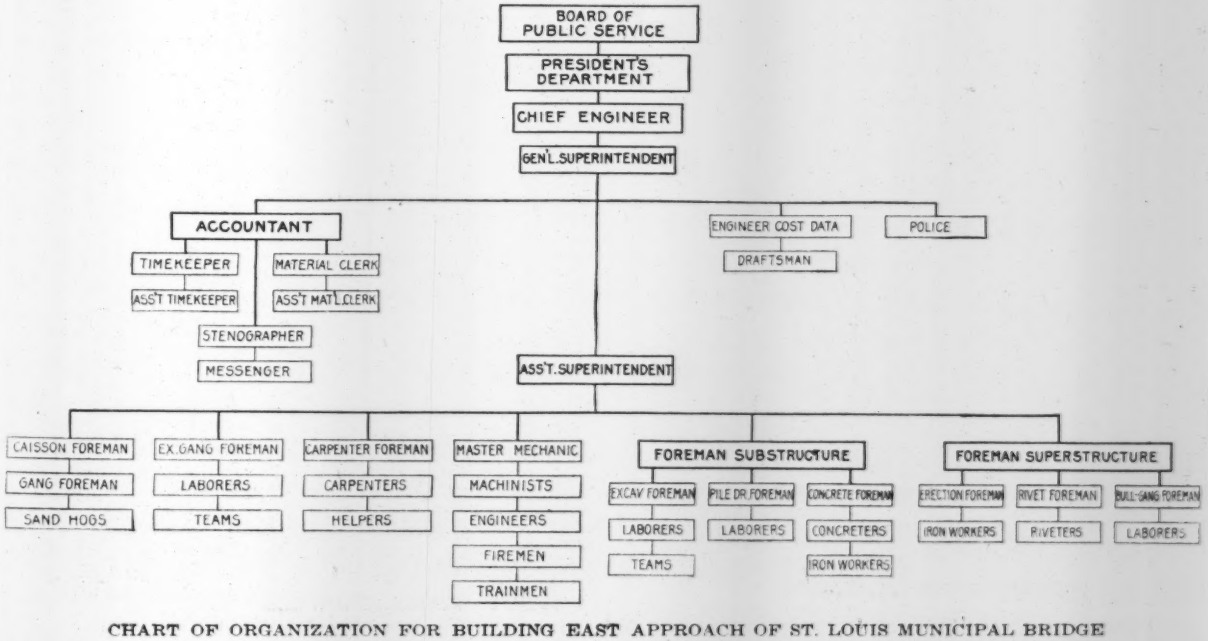


CHART OF ORGANIZATION FOR BUILDING EAST APPROACH OF ST. LOUIS MUNICIPAL BRIDGE

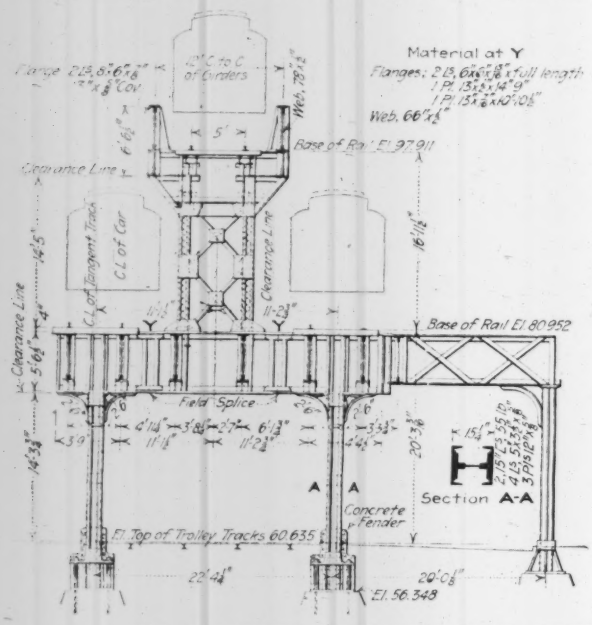
Rivets in Tension

Continuing the previous discussion in *Engineering News* concerning the admissibility of rivets for service in tension, V. H. Poss[1] describes how rivets showed their superiority over bolts in the San Francisco earthquake and fire of 1906. In those steel-frame buildings that collapsed in whole or in part, he observed that bolted field-connections had almost invariably given way by the bolts breaking off; in all-riveted work, on the other hand, the connection angles tore apart at the root, leaving each leg fast to the member to which it was riveted. This occurrence furnishes good testimony in favor of rivets in tension.

Using rivets in tension for wind-bracing connections is sound practice, Mr. Poss believes; but where load is carried directly, whether dead- or live-load, and failure would result in serious damage, neither rivets nor bolts in tension can be considered reliable.

As to the harmful effect of initial tension in rivets, he shows by an example that its influence is usually small. If the compressed area of plate under the rivet is four times the sectional area of the rivet shank [this seems a conservative assumption—Editor], then an initial stress of 12,000 lb. per sq.in. in the rivet gives a compression of 3,000 lb. per sq.in. in the plate. When tensile load comes on the rivet, it is resisted partly by further stretch of the rivet, but more by the relief of compression in the plate. The plate compression is entirely relieved by the time the rivet tension has increased to 15,000 lb. per sq.in., at which stage, therefore, the initial stress loses all its influence. Tension in rivets is actually utilized in nearly all riveted work, but especially in the cover-plate riveting of girder flanges, William Vetter[2] points out. The shear between plates is resisted by friction and not by rivet bending, and this plate friction is produced wholly by the tension in the rivet. If it is not good practice to depend on this tension, a new design for girder flanges is necessary, in which no rivet shall pass through more than two thicknesses of metal.

[1]Consulting Engineer, 57 Post St., San Francisco, Calif.



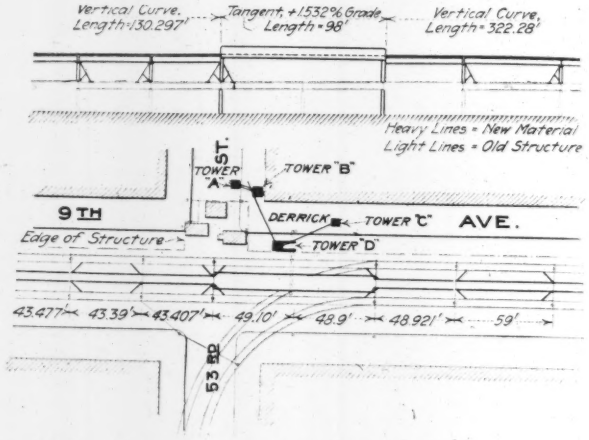


FIG. 1. "HUMP" TRACK AT 53RD ST. TURNOUT, NINTH AVE. ELEVATED, NEW YORK CITY

A Special Hoisting Job

Two plate-girders 100 ft. long had to be set for track elevation over the elevated-railway structure at 53d St. on the Ninth Ave. line, New York City, a short time ago. Inasmuch as the operation was bound to interrupt traffic, it had to be done in the shortest possible time. The contractors, Terry & Tench, Inc., laid out their plant with this end in view.

A 75-ton steel derrick was used to do the lifting. A signal-tower projection of the elevated structure limited the location in a rather awkward way, as the plan in Fig. 1 shows. To reach the final position of the girders the derrick had to be placed practically at the level of the elevated structure, about 20 ft. above street. This meant supporting the mast and stiff-legs on towers.

[2]Civil Engineer, 2463 Marion Rd., Fordham, New York City.

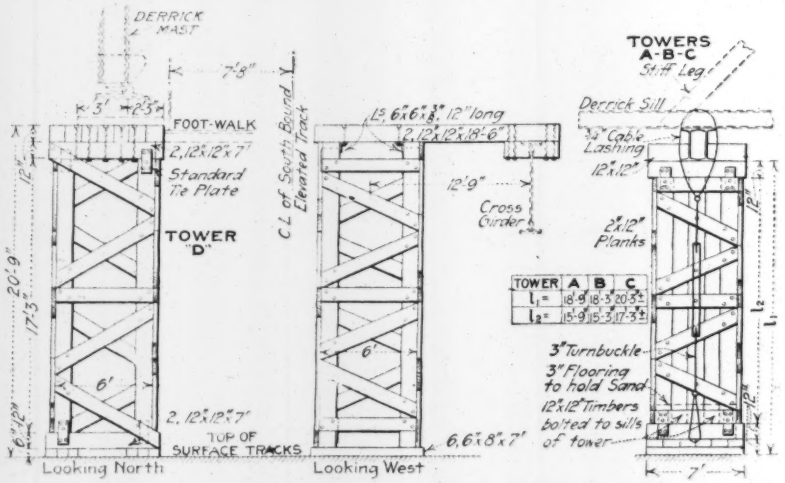


FIG. 2. DERRICK TOWERS

Fig. 2 shows in sketch form the construction of the towers. For taking the uplift on the stiff-legs these towers were filled with sand, the weight of which was taken by an anchor rope carried down from the two I-beams capping the tower to a platform in the bottom.

The long girders make a crossing of the raised middle express track over a turnout of the local track (to the Sixth Ave. line); they are located as shown in Fig. 1. Each girder weighs 27 tons. They were brought by team to the site and stored in the street just north of the derrick. In this position the derrick had to reach some 65 ft. in making the lift, but in a position where the uplift on the west stiff-leg was very slight. The girder was hoisted and the boom topped in, swinging out only enough to allow the girder to clear the mast. After getting above the level of the elevated structure, it was moved directly south by a combination of topping and swinging movements and set in place on the permanent supporting bents already erected. As soon as it was held by a few bolts, the operation of trains past the point of working could be resumed.

In setting the first of the two girders, train operation was stopped only 12 min. The second girder required 22 min. interruption.

The derrick had 36-ft. mast and 70-ft. boom, of structural steel with steel fittings. This derrick, if properly anchored, is capable of lifting its capacity at a reach of 40 ft. It has no bullwheel, but was swung by side lines from the end of the boom, going to the engine by way of lead-blocks. Tag-line tackle was also used.

While the hoist was not very heavy, the awkwardness of the location and the necessity of doing the job rapidly and with certainty made it an unusual and rather anxious piece of work. All persons concerned were gratified at the speed of working realized. Holton D. Robinson was engineer for the contractors and W. R. Coppage was superintendent. The work was done for the Interborough Rapid Transit Co., George H. Pegram, Chief Engineer.

WEIR AND SURVEYING PARTY IN BURMA

FIG. 3. HOISTING SECOND 100-FT. GIRDER AT 53RD ST.

Stream-Gaging in Burma

Engineering, wherever it may be, employs much the same methods. The accompanying view will present a familiar appearance to many civil engineers. Take away the banana trees and the bamboo, and it could well serve for similar operation of stream measurement in most any temperate country. Yet the original photograph was taken far in the interior of Burma, where few engineers have penetrated before.

The weir shown is the standard contracted weir, and the water quantities were computed by the Francis formula.

The lumber used in the weir was teakwood, freshly cut. Teakwood, when freshly cut, has a strong, not unpleasant, pungent odor which rather effectually drives away mosquitoes and gnats—a welcome relief to the European.

The young man by the level is not the engineer, but the engineer's muscles, his duty being to carry the instrument and set it up, leaving only the centering and final leveling up (and of course the reading of angles) to be done by the engineer.

The rodman, a dignified, turbaned Hindu, in his slow way was rather an efficient workman and performed his duties creditably.

It has been my observation that an unskilled laborer is the same as any other form of engine, and like any other heat engine can only perform as much work as the fuel it consumes. The Hindu is a notoriously light feeder, and most of his foods are low in calorific value; consequently he is not strong in energy.—J. D. Swaren, Hayward, Calif.

NOTES

Smooth-Break Blasting of underwater concrete pillars was recently accomplished by one Bolger, a South Carolina blaster, according to the October issue of the "Du Pont Magazine" (house organ of the Du Pont powder company). Some 3-ft. iron-incased concrete pillars, 24 ft. long, 8 ft. under water and 8 ft. in mud and sand, were to be cut down level with the mud bottom. The first attempt was by shooting holes drilled in three sides, but this gave a jagged surface. Then a cloth pocket about 2 in. wide was filled with dynamite and wrapped around the column at the proper level. After the charge was fired the break was found as clean as though the concrete had been sawn.

Long Lines in Triangulation—The longest line in the United States Coast and Geodetic Survey triangulation is that from Toiyabe Dome, Nev., to Ragged Peak, Nev., about 227 mi. This was observed only in one direction. The line from Mount Shasta, Calif., to Mount Helena, Calif., is 192 mi. in length, and that from Mount Ellen, Utah, to Mount Uncompahgre, Colo., is 183 mi. The triangle formed by Wheeler Peak, Nev., Mount Nebo, Utah, and Pilot Peak, Nev., has sides of 148, 148, and 141 mi., respectively.—August "Bulletin" of the U. S. Coast and Geodetic Survey.

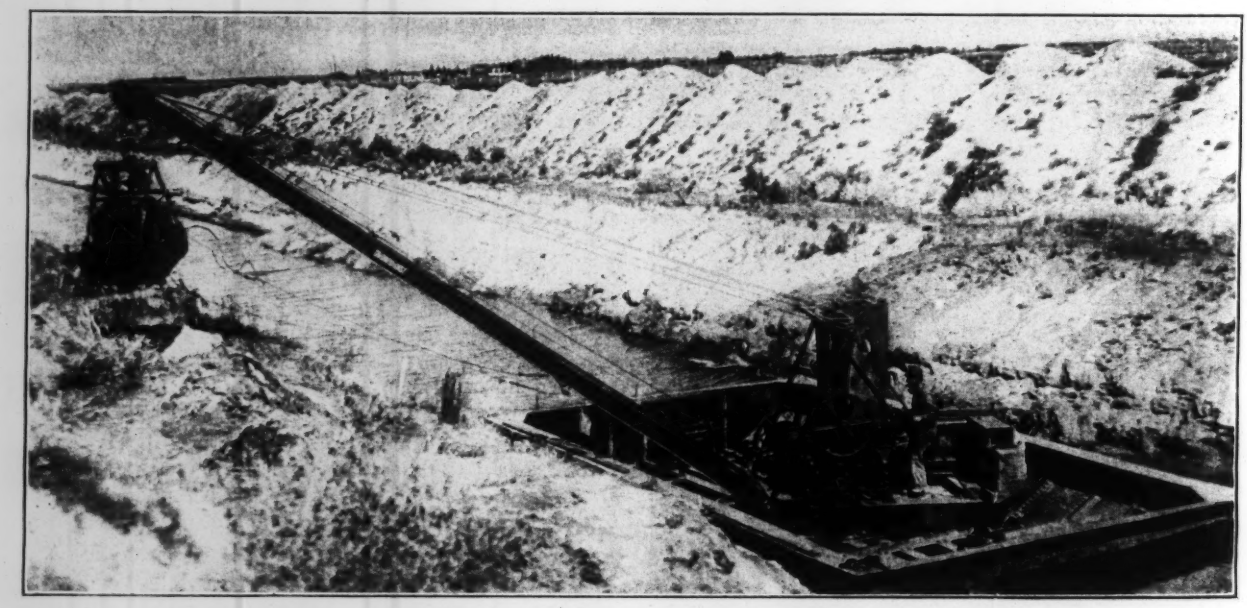
A Locomotive Crane for Ditch Excavation, mounted on a steel scow instead of on wheels, is proving economical in cleaning out the ditches which take care of waste water from the higher levels on the Minidoka irrigation project in Idaho. The Brownhoist crane is operated by a 40-hp. White gasoline engine, with an electric self-starter. It is equipped with a 33-ft. variable-radius boom and ½-cu.yd. Brownhoist bucket. The barge is constructed of steel plates and angles, and so built that it can easily be knocked down for removal to other points. A hand-operated pump is carried for emergencies. An electric-lighting system with two large lamps and reflectors has been installed to provide light for night operation. The barge and crane are designed to operate in 3 ft. or more of water, without spuds. The center of gravity is very low and the rotating parts are balanced. The crane has been in operation several months and it has been proved that it will work in less than 3 ft. of water. It is propelled along the ditch by means of hand crabs, one in each end of the barge. The rope leading from the crab is fastened at some convenient place along the bank and the barge is pulled ahead a few feet to the next digging. It requires three men for the two shifts, one operator for the day and one for the night, and a helper during the day. The silt is dug from the bottom of the ditch and deposited on the bank. F. N. Cronholn, Rupert, Idaho, is superintendent of construction for the United States Reclamation Service.

Cube Granite-Blocks for Driveway Floors are being tried in the new American Express Co. and Mail Service building of the Grand Central Terminal improvement, at 45th St., 46th St. and Lexington Ave., New York City. Owing to the lack of available depth, full-size granite paving blocks were out of the question, yet on account of the concentrated traffic of heavy mail and express trucks a granite wearing surface was deemed essential. The blocks used are 3-in. cubes of

"DURAX" GRANITE-BLOCK PAVEMENT; DRIVEWAY OF MAIL SERVICE BUILDING, GRAND CENTRAL TERMINAL, NEW YORK CITY

Salisbury, N. C., granite known by the trade name of Durax. Under the blocks is a 12-in. concrete floor, on which the blocks are bedded in a 1:2 mortar bed from ½ to 1 in. thick. After laying, the blocks were rolled with a 7-ton tandem roller. The joints were swept half full of pea stone and poured full with asphaltic cement. Although the driveways are only 144x40 ft. these pavements are notable experiments in testing the durability of small-cube granite-block pavements under heavy and dense traffic conditions. They will also be interesting in throwing light on the question of the durability of mortar beds for granite block pavements under such traffic conditions—a point now being much discussed. The pavements were laid by the Metropolitan Paving Co., New York City, which has secured the rights to manufacture and lay Durax pavements in this country.

Accumulation of Silt in Lake McMillan on the United States Reclamation project at Carlsbad, N. M., has reduced the capacity of the lake about 26% in a period of 11½ years, according to measurements recently made.



USING A FLOATING LOCOMOTIVE CRANE FOR DITCH EXCAVATION

Editorials

Color in Hydraulic Tests

New advances in hydraulic engineering having the interest and service possessed by one shown in this issue are so infrequent that they compel unusual attention. The use of dissolved coloring matter in determining flow through long penstocks and hydraulic turbines is distinctly an addition to the methods previously available, though it is perhaps essentially a development of the old float scheme of gaging stream flow.

No little credit is due Mr. Johnson and his associates for developing this test into one of accuracy and simplicity. With this development disclosed so fully as in Mr. Taylor's article, little more than some accumulated experience is needed by any engineer who desires to use this novel plan.

The color test as so far worked out is of greatest application with fairly long pipe lines where any slight errors of introduction of and observation at exit are swallowed up by a long elapsed time of transit. Future use of the method will show how far Mr. Johnson's empirical rule holds for relation between initial, final and mean time of transit; then we may see if the true mean velocity is ever less than that observed in color runs—as might possibly be the case with a very large conduit of limited length and using a single midstream injection point. This test holds out interesting possibilities for determining flow in canals and possibly in some rivers, though a vast amount of development work is essential in securing proper injection of the color and in determining what constitutes the indication of mean velocity.

⁂

Kicking Engineers Around in New York Departments

The huge sums of money that are being "saved" for New York City every day by proposed wholesale discharges of engineers in the city service and by the reductions of the salaries of such engineers as would be left is more creditable to the imagination than to the intelligence of the proponents. Here is an example—both of the "saving" and raving:

> New York City is being bankrupted by its engineers. It has just been brought out that the salaries of the engineers of the Public Service Commission amount to $2,300,000 annually. There are so many useless engineers on the payrolls in other departments that they are constantly devising means of spending the city's money in order to show some excuse for their jobs. The result is an unending series of sewer repairs, new sewers, changes of grades and widths of streets, new streets, and new improvements of all kinds. It is rumored that the engineers of the Water Board are now busy making surveys and borings for a $50,000,000 addition to the Catskill aqueduct. If two-thirds of the engineers on the payroll were discharged, the saving to the city and the taxpayers would immediately amount to millions of dollars.

Such talk almost answers itself. Some people, however, may not know that New York is building a vast rapid-transit subway system, the cost of which will run into the hundreds of millions, and those who do know it may not realize the number and complexity of the engineering problems that arise from such an immense task carried on in and beneath the streets of a great city. The subway, the new Catskill water-supply and many lesser works of large importance in the aggregate demand a good-sized army of competent engineers, many of whom must be paid large salaries.

If events prove that the present and earlier city administrations have entered upon more extensive public improvements than the taxpayers are willing to stand for, after real extravagance and waste have been cut down, then of course the engineers in the employ of New York City will stand up like men, as engineers always do, and take their fair share of the burden of readjustment. When it comes to being treated like old-time Harlem goats or "houn' dogs," that will be another matter, but until those in authority join in such irresponsible clamor as is now going on, the municipal engineers of New York will do best to continue to maintain a dignified silence.

⁂

Contractors' Bids on Their Own Plans Declared Illegal

Asking contractors to furnish and bid on their plans is far too common. What appears to be a flagrant case of this kind has occurred at Seattle, Wash., but thanks to a clear-headed and courageous corporation counsel, a farcical proceeding that might have added difficulty to difficulty has probably been averted.

The Seattle incident is connected with proposed measures to stop leakage from the Cedar Lake reservoir. (See *Engineering News*, Jan. 21, 1915.) James E. Bradford, Corporation Counsel of Seattle, was asked to pass upon the legality of the following provisions from an invitation for bids:

> The method of treating the reservoir basin to reduce loss of water by percolation therefrom will not be specified by the City of Seattle. Contractors are invited to examine the site of the reservoir and submit their own proposals for reducing the loss of water.

Mr. Bradford first points out that the city charter (Art. VIII, Sec. 14) distinctly provides that all contracts for public improvements must be let "to the lowest bidder" after public advertisement for at least ten days, during which time "plans and specifications" for the proposed work must "be on file" and subject to inspection. This language, the corporation counsel rightly says, is so plain as not to be "even open to construction."

To remove any lingering doubts as to whether the charter provision is legally sound Mr. Bradford cites some telling sentences from Coshert vs. Seattle (57 Wash., p. 649-51), in which the court declared that this very provision of the Seattle charter was designed to prevent "favoritism, fraud and extravagance" by making "intelligent competition" possible and by affording a basis "for ascertaining who in fact was the lowest bidder." That the Washington court was not alone in this opin-

ion was shown by citing People vs. Commissioners of Buffalo County (4 Neb., 150), in which the court ruled that county commissioners could not contract for a bridge "when the only competitive bidding was upon plans furnished by the respective bidders." In line with both these decisions is Dillon's "Municipal Corporations" (Sec. 807).

The case against inviting contractors to bid on their own plan is made all the stronger at Seattle by the charter provision that the board of public works cannot pass upon who submits the *best* but only upon who submits the *lowest* bid. Where each contractor submits his own plan there might be as many plans as bids, no two upon the same basis, making it impossible to say which bid was the lowest.

To drive the argument home Mr. Bradford passes from charter provisions, court decisions and expert legal opinion to a common-sense statement of the case, the gist of which is that since sooner or later the city authorities must decide upon some plan for stopping the leaks they might as well do so at once, "without fear or favor."

As nearly as can be judged from across the continent, but in the light of evidence from other and apparently similar cases, the Seattle authorities sadly confused two things that should have been kept separate—the selection of a method of stopping the leaks and of a contractor to execute the plan selected.

If the authorities desired a competition on plans, why did they not confine their request for bids to plans alone? A plan selected, real competition could then be secured for its execution and all the bids would have been on a strictly competitive basis. But even this course would not warrant placing elsewhere than upon an engineer the main reliance for selecting a plan and awarding a contract for stopping the leaks from the reservoir. There are strong indications that Seattle and some other Pacific Coast cities have been governed too much of late by laymen who put a higher estimate on their own opinions in engineering matters than upon the judgment of engineers.

Leaves and Storm-Sewer Inlets

Unless storm-sewer inlets in tree-lined streets are properly designed, leaves may be thrown down by a heavy storm and the street drainage system go out of commission under the influence of a narcotic of leaves, sticks and mud. Just such a condition as this occurred during and just subsequent to a rain and hailstorm in Jackson, Mich., in August. This was the third storm of the sort to occur there this summer, and each time the same street was flooded by the stopping-up of sewer-inlet gratings. H. K. Higgins, of Jackson, Mich., writes as follows:

> These three storms show a marked phenomenon which the writer has frequently observed elsewhere—it is not the precipitation per se that causes flooding or measures its damage, but rather the uncleanliness of streets and water courses. In the third storm there was, nearly at the time of maximum precipitation (0.8 in. in 15 min.), a heavy hail with stones measuring 1½x1½x1 in. The hail cut the foliage from trees and the leaves clogged the catch-basin inlets, which have holes 2½ in. square and a slot about 21x4 in. (the Hall inlet). The water rose after the rain had practically ceased, flooding the street, which was being paved.

There are many designs of sewer-inlet protection. Which to choose depends upon a variety of local conditions, all of which should be given careful study. The Jackson incident shows what may happen with closely grated openings in tree-lined streets. But if the openings had not been closely grated it is conceivable that the sewers, at the time of this or a subsequent storm, would have been clogged by leaves and associated material and the streets flooded just as badly. It is the duty of the engineer to guard against either contingency as fully as is possible within the funds at his command. Beyond that, he must try to select the lesser of two evils.

Small Street Cars To Compete with Jitney Busses

The competition of the jitney bus continues to be the most actively discussed subject in street-railway circles from ocean to ocean. It may well be so, for the alarming decrease reported in the earnings of some roads means either a remedy or a receivership. In the last six months many investigations of the situation all over the country have been made and the results generally agree on three points: (1) The jitney movement has popular approval in most cases—in spite of broken-down and overcrowded vehicles—and severe restrictive ordinances do not have universal approval; (2) the business tends to limit itself through the narrow margin of profit secured even by free-lance owner-drivers who do their own repairing; (3) the impossibility of running nickel busses where licenses, liability bonds and police oversight are imposed to protect the public as fully as is done against the hazards of street-railway transportation.

The small net earnings won by jitney owners constantly eliminate many vehicles, but so far there has seemed to be a good supply of venturesome spirits each with his necessary one or two hundred dollars. Evidently the street railways cannot safely rely on the movement's dying by starvation. The popularity of the jitneys and frequent public disapproval of severe ordinance restrictions make the hope of legislating the movement out of existence a precarious one.

Naturally, then, the street railways are looking for ways of meeting their new competitor with more popular and cheaper service. The scheme most talked of now is that of replacing the very heavy cars which have come into vogue with very light and small one-man types. This would give the more frequent service, fewer stops and quicker runs which seem to keep the jitneys patronized; the railway would apparently gain through decreased motive-power, track-repair and platform-labor costs per passenger. In the course of time perhaps the unit overhead charges could be decreased through smaller investment in rolling stock and track construction, for the weight of cars and trackwork has gone up as the square of the capacity of the cars, or as some higher power.

Five years ago there was a strong reaction against the heavy street cars that were being run. Street-railway engineers were discussing the details that could be lightened without sacrificing carrying capacity and necessary strength. There was pressure from the administrative officials to cut down the maintenance and power costs, but the public had not shown its preference for a light fly-away service. Neither engineers nor administrators had the nerve to plunge into such a revolution of service as is now proposed, even if they realized the pe-

culiar relation between car capacity and total expenses. A few of the small one-man cars have been put into use, but it is too early to know how successful they really are. In crowded city streets two men have been found indispensable on a car, and where the new type has appeared an extra motorman has been put on to carry the car through the congested zone. Some need of educating the public and overcoming labor-union opposition seems to be called for, but there is a field for the service, at least in the smaller cities and on outlying lines, so that if this scheme is really the preventive of impending bankruptcy, as some think, such possible obstacles will be swept away.

Embedding Street Railway Rails in Concrete

Every engineer responsible for railway-track construction or maintenance will be interested in the new type of street-railway track which is to be laid in Charlotte, N. C., and is described elsewhere in this issue by E. R. Horton, the engineer who has worked out the details of the design.

In *Engineering News* of Aug. 6, 1908, was described the design for street-railway track developed for use in Charlotte by James N. Hazlehurst, then chief engineer. In that design wooden ties were used at the rail joints and at intervals of 12½ ft. between. The main supports of the rails, however, were the concrete longitudinals, to which the rails were held by U-shaped anchor stirrups.

The most noticeable feature of this track is the lack of ties. The rails are laid upon flat steel plates which are bedded on heavy concrete stringers. It is not such prominent features, however, which will be of the greatest interest to maintenance-of-way engineers, for superficially similar designs have been employed before—and without any phenomenal success. (A recent investigation of track construction in the larger cities of this country disclosed the existence of nearly 150 mi. of the tieless concrete type—about 2% of the total.)

What track engineers will look at will be the provisions for maintaining rigidity of the running rails, especially at the joints. Play would develop at the joints from the impact of car wheels and elsewhere along the track as the result of shrinkage of the concrete. Mr. Horton seems to have forestalled trouble at both points by ingenious and well-planned construction, particularly the use of wood inserts and spring washers at anchors.

No doubt the design will receive severe criticism from those who contend that a certain amount of elasticity is a necessary feature of railway track. The earliest track was laid with cast-iron rails on stone blocks, and it promptly proved a failure. Ever since, it has been argued that it is impossible to carry the rails on unyielding supports. On a cross-country stretch of railway track some elasticity is essential; a rigid roadbed all of whose parts possess equal resistance to compression, is a financial impossibility. Compression of the wooden ties and slight bending of the rails is necessary to take up the inevitable inequalities of the surface. But when rails are laid in paved streets, rigidity is essential to long life of the adjoining pavement and the expense of maintaining an embedded elastic track makes a rigid construction feasible.

The concrete stringers supporting the rails in Mr. Horton's design are made monolithic with the concrete street paving, which is carried to the top of the rail head. The rapidly increasing use of concrete for paving makes this design of special interest from this point of view also.

To Make the Home Safer

There is great promise in a piece of work recently started by the National Board of Fire Underwriters. Experts retained by the board are studying how the house—the ordinary separate "cottage" dwelling-house—can be made more safe against fire.

Many volumes have been written on fireproof construction, and inventors and manufacturers crowd the market with materials for building fireproof floors, walls and other parts in the cheapest and most effective style. There is also a fair amount of written knowledge on fire-retardant construction and on mill construction and the like. All this is for the office, the warehouse and the factory—but not for the home.

Dwelling-houses are not built fireproof (or if they are we call them mansions), nor are they built of mill-construction type. They are wooden structures, with the wood so subdivided as to present favorable conditions for rapid spread of fire. Their frames and walls form a multitude of interconnected cells, concealed hollow spaces communicating by way of cracks and by holes cut for plumbing and heating pipes and electric wires that are threaded through these spaces. Their construction does not meet the chief requirements of fire prevention. Baldly stated, a dwelling is a firetrap.

The insurance interests have for some years made a persistent campaign against the shingle roof; so persistent, in fact, that one might have thought all other elements of the dwelling-house to be acceptable. But the fact is that the fire dangers within the house are many and varied, and the roof danger singly may be by no means the most important point of improvement. Regardless of the relative magnitude of the interior and the roof hazards, however, the following is true: That if a campaign against interior fire dangers promises to yield large results and the campaign against shingles only a small result, it is high time to take up a study of the interior risks and get the campaign started.

Thousands of home builders throughout the country will be glad to have the results of this study. Today they lack instruction or advice on the subject. They know nothing of fire prevention in either the construction or the operation of the house, and as for fire-fighting provision they know even less. Perhaps it is advisable for every house to maintain an extinguisher on each floor. If so, let the underwriters determine this fact and publish it.

A 2% to 5% increase in the cost of a house can accomplish a surprising improvement from the fire-protection standpoint. There will be no great difficulty in inducing home builders to invest this additional amount, provided they are informed in detail how to reduce the fire risk. The underwriters have undertaken to show them how.

The underwriters might well go a step farther than merely preparing advice. They might adjust the rates accordingly. In business buildings the possibility of reduced insurance rates stimulates extra precautions. Should that be neglected among the householders?

Letters to the Editor

Improved Chuting of Concrete

Sir—The editorial note entitled "Concrete Chuting Predominant," in *Engineering News* of Aug. 12, was read with much interest. It appears, however, that *the one* very important factor that has silenced much of the objection to spouting concrete was omitted. The same is true of Mr. McCullough's letter in the issue of Sept. 2.

In the days when the gravity chute was more or less of an experiment many contractors saw therein a means of placing concrete very economically, and in order to make "records" with the rather crude apparatus then available (compared with the uptodate spouting plant), the concrete quite naturally was mixed very wet to insure its "flowing" in the chute. Then, also, there was a tendency to cut down the time of mixing, since no difficulty was experienced in getting the concrete away from the mixer, as had been the case with other methods. These two conditions naturally produced results which raised a storm of adverse criticism from engineers, for the great amount of laitance (decomposed cement formed in the presence of an excess of water) present did, without question, weaken the concrete. In one case with which I am acquainted a great number of laitance spots were found in a slab placed by chute. These never did harden and could be dug up easily with a knife to a depth of an inch or so. This without question was due to the excess of water used. The basis for the widespread criticism of gravity spouting of concrete was well-founded, and contractors and manufacturers were quick to realize that unless something were done to remedy the apparent faults, this type of apparatus would be barred by engineers and owners.

Accordingly, careful study was made of the proper angle of chutes and the consistency of concrete required to enable placing the concrete without the excessive use of water. It was soon found that, with a certain minimum angle of chutes, concrete mixed to the consistency of a thick gravy and having no excess of water would flow readily—such a mixture being surprisingly slippery and possessing a sort of oily smoothness. The addition of a small amount of hydrate of lime (up to 10% by volume of the cement) was also found to make the concrete flow more readily. To produce a mixture wherein the stone is held in suspension and the entire mass clings together requires more thorough mixing than is usually done, and herein lies the whole secret of chuting; excess water is not required.

With a little experience the man at the mixer can tell, by the following indications, whether the concrete is of the proper consistency to flow well in the chutes: If, when dumped into the skip or hoisting bucket, the concrete stands up in a pile, it is too dry and requires additional water and more mixing. If it levels off and shows a covering of water, it is too wet to hold the aggregate.

Not only must the mixture be right to insure successful operation, but the flow of concrete should be steady and continuous by proper regulation at the distributing hopper at the top of the tower. Increasing the time of mixing may make this last condition difficult of fulfillment, but this can be accomplished easily by having two mixers at each plant instead of the one usually seen.

Concrete chuting has come to stay because of the great economy of operation; it is the duty of the engineer to aid in obtaining the best results, rather than to forbid its use. Given a well-designed plant, all that the engineer needs to do, as his share, is to see that the concrete is properly mixed before being discharged into the chutes. This will remove the one great objection and actually result in stronger concrete than we now obtain with rapid mixing, even if there is no excess of water present. A paper read by H. H. Scofield before the Indiana Engineering Society gave the results of tests to ascertain the effect of mixing on the compressive strength of concrete. These tests showed that the strength was increased by from 27% to over 50% by lengthening the mixing periods from 10 to 18 min. over that of the usual ½ to 1 min. It would be impossible, of course, to increase the time of mixing quite so much, but with the aid of the mixer manufacturers, by building machines of higher speed, beneficial results can be secured.

Summing up the situation, the popularity of the gravity spouting system of concrete distribution can be increased still more by the use of high-speed mixers, a slightly increased time of mixing and careful supervision.

ALBERT M. WOLF,
Principal Assistant Engineer,
Condron Co., Structural Engineers.

Chicago, Ill., Sept. 8, 1915.

Lake Okeechobee Water Level

Sir—In the editorial columns of *Engineering News* of Sept. 2, 1915, under "Everglades Drainage Problems and Florida Rainfall," comment was made concerning the water level of Lake Okeechobee, the effect thereon of recent heavy rains and the condition of the surrounding territory. It was stated that last spring the lake was at its lowest stage and that as a result of recent heavy rains it was reported that the lake was at its highest stage.

It is clear that that part of the editorial relating to conditions on and about Lake Okeechobee was founded on incorrect information. The rainstorm of Aug. 1, 2 and 3, referred to in the editorial mentioned, extended in a more or less well-defined zone 40 to 50 mi. wide across the peninsular part of Florida, with St. Petersburg the center on the Gulf and Jupiter the center on the Atlantic side. During the three days, from 8 to 15 in. of rain fell, generally within the heavier storm area. The southern edge of the storm zone passed north of the middle of Lake Okeechobee.

The level of the lake as recorded for the week ending July 31 was 16.09 ft. above sea level; on Tuesday, Aug. 3, the level was 16.42 ft.; for the week ending Aug. 7, 16.63 ft.; for the week ending Aug. 14, 16.80 ft. The rise attributable to this storm was about 0.70 ft. The lowest level reached by the lake was 15.8 ft. during the autumn

of 1914. The lake overflows its banks on the south at El. 21.5 ft. The highest water ever recorded, not due to wind tide, is 21.8 ft. Okeechobee cannot rise above this level owing to the fact that at this elevation the lake spills over its entire southern rim for a distance of more than twenty miles, faster than there is any possibility of water being supplied to it.

The effect of the storm on Lake Okeechobee appears almost insignificant in consideration of the heavy rainfall. This is due chiefly to two causes—the storm was not sufficiently broad in extent to cause general extreme floods and followed a period of rain deficiency that had prepared the lakes and ponds in the Okeechobee drainage area and the ground itself for the reception of a large amount of water, without flooding. This flood cannot be used as a criterion by which to judge of what Lake Okeechobee can do when the opportunity is really offered.

At El. 16 ft. the navigability of the lake is but slightly impaired and this over shoals bordering the south and west shores. The lake is regularly navigated in and out of the canals on the south and east and Taylor's Creek by boats of 4-ft. draft, and there are more boats on Lake Okeechobee today than ever before. Three-fourths of the lake has a depth in excess of 8 ft. when the lake level is at 16 ft.

The remarks relative to the recommendations of engineers brought out in the editorial mentioned are concurred in by myself. The foregoing is offered, therefore, not in regard to the comment on the recommendations, but in correction of the erroneous information that must have been supplied you relative to Lake Okeechobee.

Work on the canals and regulating works for controlling Lake Okeechobee is progressing.

F. C. Elliot,
Chief Drainage Engineer,
Everglades Drainage District.

Tallahassee, Fla., Sept. 8, 1915.

Does Good Iron Preserve Paint?

Sir—"Good Bridge Paint" in your issue of Sept. 9 refers to endurance of paint on a wrought-iron highway bridge for 37 years. You point out that "here is a remarkable record of paint endurance." I believe that your emphasis should be placed on the good quality of the iron rather than that of the paint. This wrought iron it would seem to me was of such purity that paint in the first case lasted 17 years and in the second case at least 20 years. With inferior quality of iron or steel, how long would either coat of paint have lasted?

I have been told that wrought-iron links which were underground at the well-known Chain Bridge at Newburyport, Mass., were intact and free of rust after 100 years of service. From personal observation I can say that the iron of this bridge was remarkably free of rust 75 years after it was built, and I attribute this endurance to the quality of the wrought-iron rather than to a protective coating.

From experiments that I have been making toward rustproofing of steel and iron I have concluded that paint or other protective coating depends for its endurance upon one important factor that must be emphasized; namely, the quality of the underlying surface of iron or steel. If the surface is rusty, scaly, granular, wet or greasy, trouble is very apt to occur; and if the surface is smoothed off, even by sandblasting, impurities in the metal itself reacting with the paint or other coating will often start disintegration. But with pure wrought iron "such as they used to have," rust does not readily occur and paint easily endures.

The subjects of rust, bridge paints, and protective coatings that will withstand atmospheric and gaseous conditions without costing too much are worthy of more discussion by engineers. It should be practicable to obtain better results than we are getting.

F. B. Sanborn,
Consulting Engineer.

Tufts College, Mass., Sept. 12, 1915.

Earnings of Graduate and Nongraduate Engineers

Sir—Referring to my letter under the above title published in *Engineering News* of Aug. 12, p. 325, and your editorial comment thereon, I have gone to the pains of making a tabular comparison on the basis which you suggest, that is counting the experience in engineering to begin when a student enters college and not when he graduates. On this basis the comparison is as follows:

Years' Experience	Monthly Salary College Men	Monthly Salary Non-College Men
1	$00	$67
2	00	78
3	00	95
4	00	105
5	67	107
6	85	115
7	110	120
8	122	130
9	133	137
10	145	145
11	160	150
12	175	160
13	190	170
14	200	180
15	210	190
16	225	200
17	240	210
18	250	220
19	275	225
20	275	225
21	285	225
22	285	225
23	290	225
24	300	225

Assume that the college course lasts four years and costs $1000 a year. That is $4000 invested, noncompound interest on which at 5% for the first five years after graduation (when the graduate's earnings become equal to the nongraduate) is $1000; and during the same time the shortage in his pay compared to the other man's amounts to $1104. At the end of six years, then, he is $6104 behind. The interest on this during the next nine years is $2745, and his extra earnings amount to $2640, about balancing that. Then his extra pay begins to wipe out the principal and in six years extinguishes it. It is now 21 years since graduation, and from this time on the graduate gets $900 a year more than the nongraduate. But by this time half of the graduates have dropped out. So that the conclusion is that in, say, 20 years the college education will pay for itself, and as only half stay the 20 years out we may say that for half of those who graduate college pays.

The figures used above are supported by data at the beginning and end of the term; intermediate ones are interpolated. The figures for the end of the term are taken from the diagram in your issue of Jan. 7, 1915, the line for graduates being shifted four years to the right so as to make their experience date from college entrance.

Civil Engineer.

Nashville, Tenn., Aug. 17, 1915.

Automatic Cab-Signal and Train-Stop System

SYNOPSIS—This railway signaling system gives both visible and audible signals in the engine cab, and supplements these by a service application of the train-brakes if a "stop" signal is disregarded. A special feature is that the connection between the track and engine equipment is by magnetic influence only, so that no contact is required.

An interesting example of the development of cab signals and automatic train stops is found in a system placed, on Sept. 22, in service on the main line of the Western Pacific Ry. This installation comprises five miles of track at the district terminal at Oroville, Calif., and 20 locomotives used at this terminal are equipped with the necessary apparatus. The distance is divided into four block sections. There are 9 fixed-signal locations, at which 20 track devices are arranged for giving 15 cab-signal indications and 7 automatic-stop operations. The system has proved satisfactory under unfavorable conditions caused by snow and bad weather.

Both visible and audible signals are given in the engine cab for three indications—"proceed," "proceed under control" and "stop." Electric lights (green, yellow and red) form the visible signals. The others are whistles of three distinct tones, which continue to operate until the connections are restored to normal position by the engineman. If signals are not obeyed, the automatic train stop gives a service application of the brakes. This cannot be released until the train has been stopped, but it does not prevent the further application of the brakes by the engineman. Provision can be made for rendering the train-stop device inoperative when the speed is below a given rate.

The transmission of signals from the track to the engine is effected by magnetic impulse only, and there is no electrical or mechanical contact between the parts on the track and those on the engine. The general arrangement is shown in Fig. 1. The track magnets are located between the rails, there being one for each of the three signal indications and a fourth for the train stop. Each track magnet, when energized, transmits signals for traffic in either direction.

The magnet is inclosed in a waterproof case 15⅞ in. long, resting on the ties and having its upper surface 1¾ in. above the rails. It requires an energizing circuit of 5 amp. at 10 volts, and normal operation takes current for 15 sec. only. The magnets are protected from hanging brake rods, etc., by 48-in. ramps or inclined blocks faced with steel plate.

Beneath the tender is a cross bar carrying the receiving coils, one for each signal and a fourth for the train stop. Each coil receives and transmits magnetic-impulse signals for traffic in either direction. This is shown in Fig. 2.

Each track magnet is so located that the corresponding receiving coil on the tender will pass directly over it. The cross bar carrying the coils is so placed as to provide a clearance of 3 in. between the magnets and coils. The extreme lateral or vertical movements of the engine cannot carry the receiving coils out of the magnetic fields of their respective track magnets or cause wrong signals to be given. Each magnet is entirely inclosed by a substantial, water-tight metal box, amply protected from injury. There are no moving parts in or about either the track magnets or the receiving coils.

Each fixed signal location has a standard railway battery set of 10 volts, with the necessary controlling and protective relays, wiring and trunking, and one or more track magnet boxes, according to signal needs. By means of a local track circuit, the track magnets are energized when an engine is 66 ft. distant and remain energized until after the tender has passed over the track magnet boxes at that location.

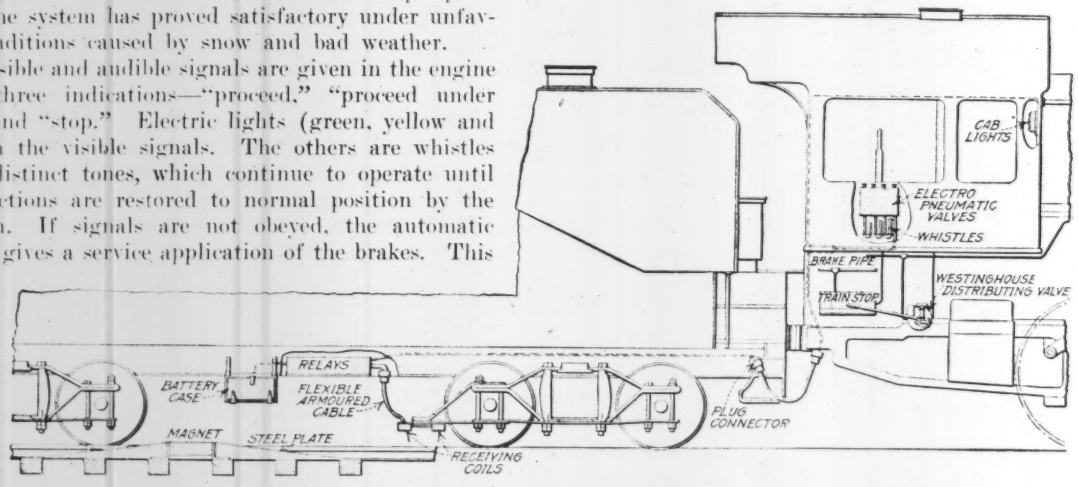


FIG. 1. TRACK AND ENGINE EQUIPMENT, BOSTWICK CAB-SIGNAL AND TRAIN-STOP SYSTEM

The apparatus on the engine consists of 4 receiving coils, 4 relays, a storage battery of 2.5 volts, 4 electro-magnetic-control air valves, 3 electric lights, 4 whistles and the train-stop appliance. A receiving coil, actuated by its energized track magnet, transmits the signal impulse through its relay, electric connections and air valve to its cab light and whistle. The train-stop apparatus is similarly controlled and actuated, except that its valve is vented. Each operation of the train stop is automatically registered and the engineman held accountable therefor.

A visual signal at each train-stop location is the only roadside signal used. This consists of a simple, hooded, two-light marker for proceed indications, operated from the battery at that location. Closed circuits are used

with electric control. Wherever air control is used, any leak or break will cause warning signals to be set against approaching trains. Fig. 3 shows one of the fixed-signal installations at the end of a block, with the relay cabinet and the track magnets.

The receiving and relay coils are of relatively high resistance. The relay magnets are powerful enough to

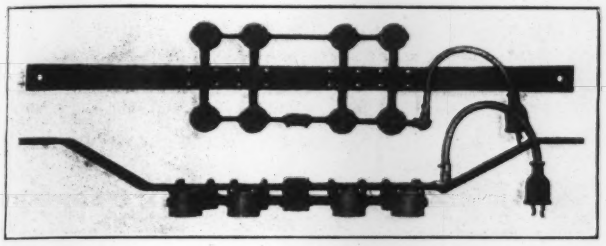


FIG. 2. GROUP OF RECEIVING COILS ON LOCOMOTIVE TENDER TRUCK FRAME

prevent contact from being opened through any engine vibration or shock, and the battery current is not essential to perfect relay operation, but is used to give protection against the breaking or loosening of any wire or connection.

The operation of the signal device is shown in Fig. 4. As the receiving coil passes through the field of the energized track magnet, a current is generated in it which is more powerful than, and flows in the direction opposite to, the battery current normally circulating in the receiving coil and relay. The action of this induced current momentarily reverses the magnetism of the relay, permitting its armature to drop and open the circuit to the cab apparatus. The armature is immediately reattracted to normal position. This interruption of the circuit deënergizes momentarily the iron-clad magnet *A*, causing the release of its armature *B*, which normally is tightly held to the poles of the magnet.

The lever *C* rises with the armature, and the air in the air supply pipe (connected with the engine main air reservoir) is thus permitted to unseat the valve and flow to the whistle. At the same time, the disk *D*, rising

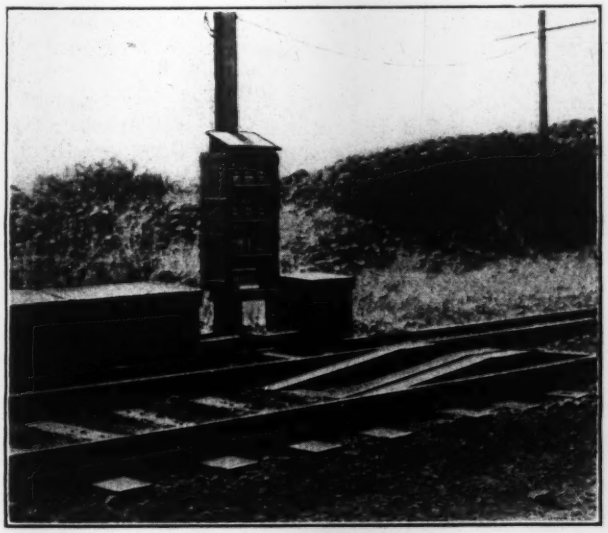


FIG. 3. FIXED SIGNAL INSTALLATION AND TRACK MAGNETS AT A BLOCK SECTION

with the armature stem, closes the contact springs *E* and lights the lamp. The armature is restored to normal position only when the knob *F* is depressed, which opens the contact springs, thus cutting out the signal light and closing the air valve. Fig. 5 shows the whistles and their control valves.

The foregoing description applies to each of the three sets of apparatus for signal indications. A fourth set of the same apparatus, omitting the lamp, is provided for the operation of the automatic stop. This is operated in the same manner as described except that the valve connecting with the automatic stop (outside and below the cab) is a vent instead of a supply valve. The alarm whistle of the automatic stop is located at the base of the automatic-stop valve apparatus. When the automatic stop has been operated, pressure on the knob *F* restores the vent valve to normal position, but the ser-

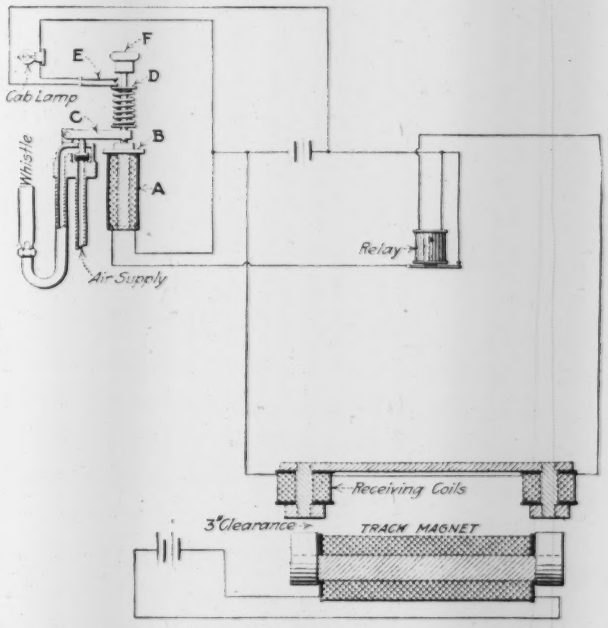


FIG. 4. DIAGRAM OF TRACK AND ENGINE EQUIPMENT

vice application of the brakes given cannot be released until the train is stopped, when the engineman must restore it from the ground. The necessary reversal of the operation of the receiving coils when an engine has been turned is provided for by a reversing switch.

The train-stop device (Fig. 5), is connected to the brake pipe, and is pneumatically operated and electrically controlled. When it has applied the brakes they cannot be released until the device is restored to its normal position (although an emergency application can be made). This requires first pushing the knob of the electric vent valve in the cab, and then pushing the release button of the tandem valve, which can be reached only from the ground. When this is done, the engineman can release the brakes and proceed, subject to the indication of the roadside signal or marker. When two locomotives are attached to a train, the automatic stop is operative only on the head engine.

The circuits are shown in Fig. 6, but only as controlling the train stop. The block sections are insulated in the usual manner, and failure of any part of the appar-

atus will cause the signals to be displayed in the same way as if the block were occupied by a train.

Block No. 1 is supplied with current at *A* by the track battery *B*, the current being carried by the rails to *C* and thence to the relay *D*. In normal position, with no trains in the block, this relay attracts its armature

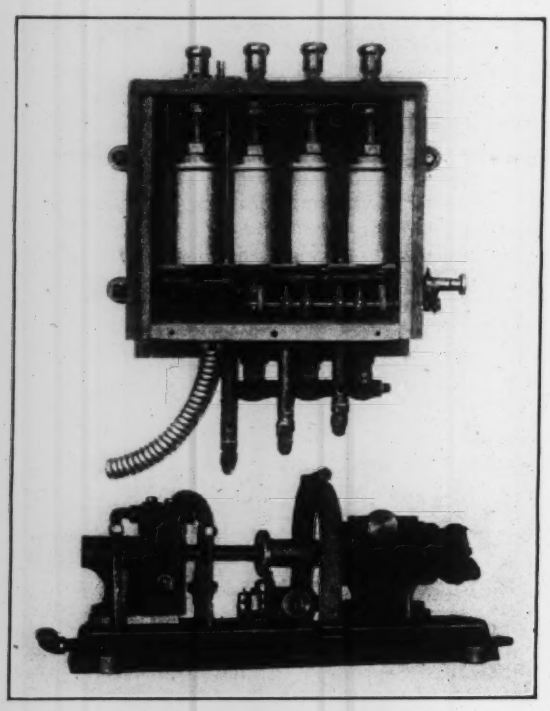


FIG. 5. AUDIBLE SIGNALS AND TRAIN-STOP

The upper view shows the signal whistles, with their electro-magnetically controlled air valves. The lower view shows the train-stop device in its open position

and connects battery *E* with the line relay at the far end of block No. 2. This latter block is supplied with current in the same way (at its far end), and the relay *F* connects its battery *G* with the line relay *H* of block No. 1.

Should opposing trains enter the two blocks simultaneously, the current supplying relays *D* and *F* would be cut off. These relays and the line relays would then drop their armatures, thus giving the signal indications in the engine cabs. The spacing of the signals is sufficient to enable the engineman to stop the train before coming to a "stop" signal, but the train-stop connection is set far enough in advance to bring a train to a stop before it can enter the danger zone.

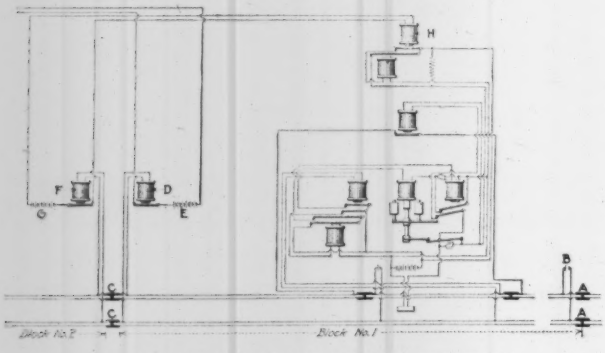


FIG. 6. DIAGRAM OF SIGNAL CIRCUITS

The automatic cab-signal and train-stop system here described is the invention of F. F. Bostwick, who is President of the National Safety Appliance Co., Mechanics Institute Building, San Francisco, Calif. The equipment described has been developed by W. S. Levin, chief engineer of the company, who has been in sole charge of design and construction, and to whose practical inventive ability is credited the successful completion of the system. It is applicable to single and double track, and for steam and electric traction. It may be used with or without the train stop. It can be applied also in connection with existing signaling and interlocking plants.

New Process Recovers Potash

New schemes for winning potash from American sources of supply continue to show the ingenuity of engineering chemists. The latest announced process was described by Edward Hart, of Lafayette College, Easton, Penn., in the August issue of the *Journal of Industrial and Engineering Chemistry* of the American Chemical Society. A plant has been erected by the Clinchfield Products Co., at Erwin, Tenn., in close proximity to supplies of cheap coal and barytes, both of which are needed. The potash to be recovered is contained in large quantities of refuse from feldspar mines, running as high as 9% in potash and 15% alumina.

Briefly, the process consists in heating a mixture of feldspar refuse and barytes in proper proportion in a reducing atmosphere where a barium-aluminum-potassium silicate results containing about 36% silica. This is run into water while molten, and the granulated material is ground and floated. The settled material is then treated as a paste with the proper quantity of sulphuric acid, which decomposes it perfectly, giving a solution of alum and aluminum sulphate and a solid residue consisting of nearly equal parts of very finely divided barium sulphate and silica.

It might be supposed that the silica would be so gelatinous as to be unwashable, but this has not been found true. On the contrary, where properly manipulated, the precipitate is somewhat granular, but entirely free from grit, and forms an excellent material, after ignition, for use as a pigment in printing ink, rubber incorporation and as a coating for paper.

The solution, when evaporated, yields the potash as potash alum, and if the little iron present be kept in the ferrous condition, this alum, after washing with a little water and whizzing, is entirely free from iron and well suited for the preparation of pure potassium sulphate and iron-free alumina or aluminum sulphate, as desired. It is intended to sell the alum as such so far as the market will take it and to decompose only so much of it as may be necessary. This process may therefore furnish no potash at all. But inasmuch as potash for alum production now comes from overseas, this method is an indirect contribution to the supply.

The solution never contains enough potash to precipitate all the aluminum as alum. An excess of aluminum sulphate remains in the mother liquor together with the sodium and a little iron. This is allowed to cool and is broken up, furnishing a material equal in value to that now made from bauxite.

Color Used in Hydraulic Tests of Power Plants

By Roy Taylor*

SYNOPSIS—The injection of coloring matter has been employed in the roughest class of hydraulic-flow measurements, but very little has been reported of the possibilities of this test for accurate determinations. Details are presented of the method and apparatus developed by R. D. Johnson and associates for color tests at the Niagara Falls and Salmon River plants of the Ontario Power Co. Use of potassium permanganate and aniline dyes.

The use of coloring matter in water for rough measurements of sewer velocities, river currents and to detect leakage through dams is not unknown; but engineers in general fail to realize the practicability of this scheme in the measurement of water consumption at hydro-electric works and similar hydraulic developments where there are long pipe lines. This is no doubt because of the slight information of a practical nature published on the more refined color tests. The writer contributes these notes on two specific cases in the hope of helping to fill the gap.

It is hardly necessary to discuss the fundamental idea of the color tests beyond stating that the coloring matter is injected into the pipe system at a known point and at an observed time, the interval being recorded before it appears at the outlet of the pipe line or power plant. The computation of quantity of water flowing is extremely simple; it merely requires dividing the total volume of the system, between points of introduction and observation, by the time. The actual practice required for accurate color tests is not so simple as the preceding statement, as will be evident from the descriptions of trials at the Niagara Falls and Salmon River plants.

Color Tests Made at Niagara Falls

Several years ago color was used in a series of tests conducted at the plant of the Ontario Power Co., Niagara Falls, to determine the relation between quantity flowing and loss of head in its two 18-ft. conduits. These are each about 6,300 ft. in length, one round in section and built of steel, the other slightly oblate in section and constructed of reinforced concrete. These first tests were not extensive, but served to bring out the possibilities of the use of coloring matter in the measurement of water, so that during the summers of 1913 and 1914 a complete calibration of the plant was made and valuable information as to head losses, water consumption, velocities and efficiency of each of the 14 units was obtained.

It was decided to use color for these tests for several reasons: It had proved satisfactory in the first instance; to construct any form of weir in the tailrace was almost impossible, and, finally, as it was dangerous to approach and work near the tailrace, it was impracticable to use any method involving the percentage of solution and requiring constant taking of samples. The color method was therefore adopted for all measurements of water. When a few difficulties had been surmounted and the methods of running the tests had been systematized, results were obtained which are believed to be as accurate, if not more so, than could have been obtained by the use of any other method, not excluding that of weir measurement in this case.

Prior to testing the efficiency of each separate unit, a series of color runs was made on the two conduits to obtain an accurate relation between the flow in the pipe and the corresponding quiescent gradient level existing in the spillway on conduit No. 1 and in the surge tank in the case of conduit No. 2. These water levels were very sensitive to changes in conduit velocity, so that once the relation was established it became an easy matter to compute the flow in the conduit at any time by referring to the water-level chart of a recording graphic meter.

Introduction of Potassium Permanganate

The Niagara water is always comparatively clear, and the color runs in general occupied less than 12 min., so that potassium permanganate proved to be the most satisfactory, and at the same time the most inexpensive, substance with which to color the water. It is a very powerful stain turning the water a dark purple color, and the commercial product is easily obtainable at a price of less than 20c. lb. (with an ordinary market). It comes in the form of small crystals and can be introduced into the water without further preparation as it dissolves very quickly.

In the present instance, to introduce the color properly at the forebay entrance to the pipe lines presented a considerable problem, as the center of the pipe was 15 ft. or so below the floor and the velocity was over 18 ft. per sec. After failures with several rigs a device made up of iron pipe was constructed (see Fig. 1) which proved definite in action and simple in operation. The rod running through the handle was first drawn up and fastened with a pin so that the cover or piston on the end of the rod acted as a cork in the 4-in. cylinder; then the dry crystals were poured into the cylinder through a hole in the side, having a removable plug. The pipe was lowered into the water and at a definite time the pin removed and the handle rammed down, the end piston uncorking the cylinder and the upper piston ejecting the entire contents into the current almost instantaneously, at a point very close to the center of the pipe.

An observer stationed on the power-house roof noted the time to the nearest second, when the first trace of color appeared, the time of maximum color density and the time of the last trace. The mean time between the first and last trace, which usually corresponded to the time of maximum density, was used in computing the total elapsed time. (The reason for this will be discussed later.) Watches held by the man introducing the color and by the distant color observer were carefully checked by telephone after each run. The amount of color injected for one shot depended somewhat upon the conduit velocity

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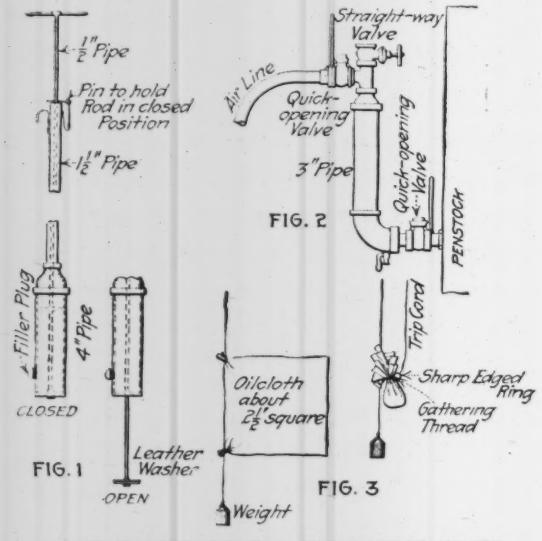
and the load conditions existing at the time, but it never exceeded one cupful of crystals. The amount was constantly varied, the aim being to use sufficient to make the color clearly and sharply visible to the observer and yet not enough to drag out the persistence of color unnecessarily and make the readings indefinite. An observer at first will experience some difficulty in catching the time of maximum density, but with a little practice it becomes comparatively simple.

Over 60 runs were made by this method on the two Niagara conduits, embracing flows as low as 2,000 cu.ft. per sec., or a conduit velocity of 8 ft. per sec., and a maximum flow in the concrete conduit of about 6,600 cu.ft. per sec., corresponding to a conduit velocity of 26 ft. per sec.

Testing Power Units by Color Runs

To test each unit separately the color had to be forced into the penstock, at a convenient point near its upper end, with compressed air in order to overcome the pressure head of 50 ft. existing at that point. The apparatus shown in Fig. 2 was devised to accomplish this and could be easily attached to any penstock and connected up to



COLOR INJECTORS FOR HYDRAULIC TESTS

Fig. 1—Dry potassium permanganate injector. Fig. 2—Compressed-air permanganate-solution injector. Fig. 3—Dye bag and release

an air line near-by. The permanganate crystals were dissolved in water (saturated solution) and about a pint of this liquid was sufficient to give a good color. A charge of this size could be poured into the cylinder and by means of the compressed air could almost instantaneously be injected into the penstock with a force sufficient to carry it well into the stream. In filling, the quick-opening valves were closed and the cylinder drained through the pet cock; then the straight-way valve was opened and the stain poured in. In discharging, the filling valve was closed and the air-line connection opened. At a definite time the valve at the penstock was opened and a bell signal given the discharge observer. In refilling, the penstock valve was shut and air pressure cut off; then the air pressure was released and the cylinder drained through the pet cock.

The schedule adopted was to hold the machine under test at a certain constant gate opening and, when all disturbances of the water had quieted down, to introduce six injections of color at about 1½-min. intervals. The observer was stationed on the power-house roof with a stop-watch and an electric buzzer beside him. The latter was connected to a push-button in the valve chamber where the color was put in. Two rings were given the observer as a warning 10 sec. before the introduction of color, followed by a signal-ring simultaneous with the opening of the valve and injecting the color. At the signal bell, the observer started his stop watch and later recorded the color appearance (to ⅕ sec.), as previously described, in this way eliminating all errors due to watch corrections by having all times recorded to a single watch. The elapsed time before the color passed completely through to the tailrace on full-load runs was only about 31 sec., so that accuracy in time recording was of great importance. In computing the results, to eliminate small discrepancies, the six runs were averaged and considered as one point on the efficiency curve. The gate opening on the machine was then changed and another set of runs taken.

Slight errors in time resulted from the various lengths of paths followed by the particles of water in getting through the turbine casings. On conduit runs any error thus caused was so small a part of the total elapsed time as to be inappreciable; but in the runs on separate units where the total elapsed time was in some cases as low as 31 sec. it affected the results to the extent of from 1 to 2 per cent. As this error was practically the same on all machines, it could be corrected in the final results by arbitrarily revising the computed drafts of each turbine proportionately, until their total checked with the accurate measurement of flow in the conduit as determined from the gradient level in the tank and spillway. By this process the true efficiencies of the different wheels at all gates were obtained.

Tests at Salmon River Plant

The results of these Niagara tests were so uniformly satisfactory that upon the completion of the Salmon River Power Co.'s plant at Altmar, N. Y., it was decided to conduct similar tests to determine the best ways and best gates at which to operate the four 7,500-kw. units, their efficiencies, the frictional losses in the pipe line, and to calibrate the tailrace weir so that the records from it could later be used to keep track of water consumption. This work was carried out during October and November, 1914, under the direction of R. D. Johnson, who had previously supervised the tests made at Niagara. The color method was adopted in this instance because sufficiently accurate and at the same time less expensive to carry out than any other.

As this Salmon River plant is typical of a large majority of long-pipe-line hydro-electric developments, the methods used and the results obtained will be discussed in some detail.

The general features of this plant are as follows: The water is carried from a large reservoir by means of 600 ft. of rock tunnel, 7,800 ft. of 12-ft. wood-stave pipe and 1,200 ft. of 11.5-ft. steel pipe, making in all nearly 10,000 ft. of conduit. This leads to the top of a high bank just above the power house. From here it is dropped down the hill in four 8-ft. steel penstocks each connecting with a 7,500-kw. unit in the power house. On leaving the draft tubes the water flows out under a curtain wall at the end of the power house, through a rock cut to a

concrete weir wall several hundred feet downstream, thence through a rough artificial channel into the river some distance below.

Use of Aniline Dye

The same substance that had been so successfully used in the clear waters of Niagara River proved to be absolutely invisible in the dark brown waters of this river, even when introduced in large quantities. The reservoir had been filled but shortly before, leaving a large quantity of vegetable matter in the water. Upon this the strong oxidizing properties of the permanganate acted and during the 2-mi. journey, changed from its natural deep purple color to a muddy brown very similar in shade to the vegetable-stained river water.

It therefore became necessary to procure a brilliant red aniline dye which would be unaffected by the character of the water. Before diluting this dye in water it is a bright red, but when a small amount of it is put into a considerable quantity of water it gives the solution a light green opaque color (by transmitted light). To the observer this color is very clearly distinguishable against the dark brown of the water. Observations of the color were taken at the point where the tail water emerged from the power house and noted the usual three times. On some of the long runs, occupying over an hour, the presence of the color could first be detected by the flecks of foam taking on a pink shade (from reflected light), and in all cases this coloring of the foam seemed to be a very sensitive indication of the first trace of color reaching the tailrace. It is a good idea to purchase the dye in what is called a paste, but which really is a semi-liquid, for the powdered form cakes when put in water and has to be thoroughly dissolved in hot water before it is fit to use.

Importance of Quick Injection

Too much emphasis cannot be placed upon the importance of introducing the coloring matter in the proper way. Any failure of the injecting apparatus to work, premature dumping of the color, leakage, or fouling of the operating apparatus causing the color to dribble out slowly—all are invisible to the man operating it, so that under any of these conditions the time of introduction is at best very vague, if not altogether unknown, producing results of no value. Any apparatus that is uncertain of operation cannot fail to cause a lack of confidence in all results obtained. The color should always be injected suddenly; it should be in a form which will quickly dissolve or dilute and it should also be released where it will be sure to be caught by the current and whirled immediately into the main flow.

The case in question presented particular difficulties, as the only place where the color could be introduced was through an opening in the gate-house floor just behind the screens. The water surface stood 30 ft. below this floor and the pipe entrance 15 ft. below that. Fig. 3 shows a form of device that proved to be very definite of action and satisfactory in every way. A pint or more of the color could be held in the bag formed from the square piece of oilcloth. The bag was closed by gathering at the top and bound around with a thread. On the trip cord was fastened a sharp jagged wire ring through which this gathering thread passed, so that when the color had been lowered to the desired point, the trip cord could be jerked at a definite time, cutting the thread and releasing the color in one compact dose with no chance of its being strung out.

The time taken by the color to make its way down the pipe through the penstocks and units, into the tail race varied from 12 min. with all four machines running at full gate, to 1 hr. 23 min. with only one wheel running at 0.4 gate.

During all the tests the electrical load carried by the plant was tied in with that of the Ontario Power Co. at Niagara Falls so that any fluctuations of commercial load were carried by that plant and it was possible to put the Salmon River units under hand control during the entire runs thereby holding the gate openings constant.

Checks on Color Tests

Weir readings in the tailrace were taken every ½ min., and the quantity figured from a discharge curve previously made up. This was used as a check on the color runs. Two other rough checks were possible by figuring the quantity from the turbine gate openings considered as submerged orifices, and from the electric load and estimated efficiency characteristics. Readings of the water level in the surge tank at the top of the penstock and pressure gage readings at the bottom of the penstock were taken so that pipe-line losses, penstock losses and net operating head could be determined. The surge tank level, especially for large flows, became very sensitive, and when a loss curve was established this level became an accurate way of checking the results of any single color run.

The total volume was carefully figured and as the different units were taken up small corrections were made for the different tailrace lengths and short sections of pipe line between penstock entrances.

When two or more wheels are tested together the gate openings should be kept about equal, especially in the case of long penstocks, as otherwise the color will be strung out, moving faster through one penstock and wheel—that is, the larger gate opening—than through the other. In figuring the volume all penstocks, wheel casings and draft-tubes must be included. Errors are easy to make and should be guarded against wherever a division in the channel, pipe, or water course takes place.

Eliminating Discrepancies in Results

With all these various factors dependent upon one another it is apparent that any error resulting from incorrect readings, poor observations, wrong times, or freaks of eddy currents and waterwheel runners, invariably can be picked up and investigated. Unavoidable discrepancies, by weighing the causes of error, can be smoothed out and adjusted until the final results have a higher degree of accuracy than it is possible to attain from any one system of measurements. Provided no freak is found; the friction-loss curve, the weir-discharge curve, the curve between gate openings and quantity and the wheel efficiency curves, should all be relatively smooth and the results of any one run should fall on them all or be investigated.

As an example of the value of this checking one case may be cited. The tests on one unit disclosed the fact that the relation between gate opening and draft was not like that on the other units, and that the efficiency had fallen off. The wheel was shut down and upon

examination several large blocks of wood were discovered jammed between the runner vanes.

About 40 color runs in all were made in the tests at Salmon River, and two facts of special interest were brought out—the time between the first and last trace was invariably equal to about one-tenth the total elapsed time, and the maximum density of color occurred at about the mean time between the first and last trace.

Injected Color Strings Out

The first phenomenon is interesting since according to the supposed theory of flow in pipes a great deal more stringing out of the color should have occurred, owing to the difference in velocity at the center and along the surface of the pipe. This may be accounted for by the fact that the separate particles do not flow along in a straight longitudinal direction, but twist and turn in eddies and at bends, so as to flow partly with the fast moving center and partly with the dragging water along the sides, the resultant being an evening-up to the average rate of travel. The results show that the last particles of color visible must have flowed at a rate of about nine-tenths that of the fastest, and this difference is intensified by the right-angled bend into the penstocks and the difference in length of path of the various particles in going through the turbines.

The fact that the point of maximum color occurs at the mean time between the first and last trace indicates that the greater proportion of particles have traveled at the mean rate. As the grading off of color was uniform and similar in both directions, it would appear that the time at which this maximum density occurs is the proper time to be used for computing the average rate of flow through the pipe. No proof of this is possible, without calibration by some more accurate method, if such exists; yet it is firmly believed to be near the truth.

At every opportunity this theory has been checked in one way or another, and no reason to doubt its correctness has as yet been found. On several of the slowest runs, rod floats were allowed to drift down the tailrace, and from the known volume the quantity was figured and found to check with that computed from the color. Again, the weir, which was a rather rough-topped concrete wall with an unknown coefficient, was calibrated by means of the color runs and the resulting discharge curve proved to be a true three-halves-power curve with a definite coefficient, in a general way showing the color method to be consistent within its range. As further checking by means of pipe losses and computed flow for different gate openings disclosed no error, it seems certain that very little error will result if this theory is adopted. In cases where a slight difference occurred between the mean of first and last traces and the time of maximum density, they were corrected according to the weighted probable degree of accuracy of observation, and averaged.

Proper Status of Color Tests

Substances other than aniline dye and permanganate have been tried out at various times but none has proved satisfactory. Shavings, sawdust, confetti and oil were experimented with at the Salmon River plant; but all are open to the same objection, that of dragging out the final traces to such a degree that all accuracy in the observation is lost and any recorded times are at least uncertain and indefinite. Where the water to be measured is clear and free from vegetable stain and the time of color-runs is not too great, potassium permanganate probably will prove the cheapest and most satisfactory substance to use, while in muddy streams or with long pipe lines affording sufficient time of transit for oxidation to take place, either a brilliant green or red aniline dye will be necessary.

In conclusion it may be said that if ordinary care is used to avoid unnecessary errors, if the color is introduced in the proper way and just enough is injected at a time to be clearly visible to the observer, the results obtained from color-run tests should have a higher degree of accuracy than those from the common methods of water measurement now in use, such as current meters, pitot tubes, rod floats, or even by the method of chemical solution; and will compare very favorably with results obtained from the standard test weir. Without doubt a carefully constructed sharp-edged test weir is the most accurate device for flow measurements; but in most cases it is impracticable to build one—either on account of the expense or the lack of a suitable location or because the quantity of water is too great to come within known experimental calibrations.

Color Test an Aid to Operation

With color, tests can be made conveniently at widely separated dates to determine the falling off of plant efficiency, the effect of any alteration or wearing of the waterwheel runners, etc.; whereas it is often most inconvenient to reconstruct a special weir during normal operation. For all such reasons it seems strange that this method is not more frequently used in connection with hydro-electric tests. It is applicable to any plant having a pipe line or long penstock, can be used without interruption to the commercial load, is inexpensive and with a moderate amount of care will give results that are sufficiently accurate for all practical purposes.

Roofs and Floors in Africa—Corrugated iron would seem on casual inspection to be the favorite roofing medium in Portuguese East Africa, but a tendency is manifest to replace it by materials more easily handled and at the same time less conductive of heat. United States Consul George A. Chamberlain, Lourenco Marques, believes that there is a promising market in his vicinity for modern roofings and floor coverings. Local builders state that pitch or asphalt or patented roofings are rapidly replacing old roofs. The floors in Lourenco Marques are of two kinds—in the cheaper houses of wood, and in the more expensive of parquet, tile or mosaic. The idea of the tile and mosaic floors is that they are cool; but at the same time they are tiring to the feet. Board floors, unless very carefully laid, give easy ingress to insects and vermin, which are very prevalent. Modern types of roofs have been introduced into Tripoli, Libya, since coming under Italian influence. Of the 1,050,000 inhabitants of Libya 95 per cent. are Arabs, and the largest portion of these are nomadic. Natives who live in the Oases haxe fixed habitations, with simple houses of stone ,sun-dried brick or packed earth, with roofs of date-wood rafters overlaid with palm leaves and straw and the whole covered with a coating of lime plaster. In coast towns the principal building materials are stone and brick, with flat roofs covered with lime concrete. Sloping roofs have now been introduced. A roofing that seems to have been favorably received is known as "Eternit" and is an artificial stone composed of asbestos, other mineral substances and chalk, mixed and hardened with acid. It is produced in sheets by an Italian firm at Casale Monferrato and costs about 5c. per sq.ft. This material can be cut without cracking, and nails can be driven through it. It is estimated that fully 75 per cent. of the $40,000 imports of roofing materials in Tripoli in 1913 were of "Eternit."

News of the Engineering World

New Carnegie I-Beams Rolled

An important change in its I-beam rolling is announced by the Carnegie Steel Co.—the production of a new line characterized by wide and thin flanges and flange bevel flattened to 1 in 11, the previous standard being 1 in 6. The sizes of I-beam to which this applies are 27, 24, 21, 18, 15, 12, 10 and 8 in. deep.

These beams are a development from the high-efficiency (thin-web) beams brought out a year or two ago. The introduction of the 27-in. size, and of the 21-in. size to replace the 20-in., was a feature of that line, as was also a tapered thickening of the web at its junction with the flanges. The new wide-flange line also has the 27-in. and 21-in. sizes, thus giving a 3-in. gradation down to the 12-in. depth and a 2-in. gradation thence to 8 in. In other respects, however, the new beams differ radically from the high-efficiency beams.

The webs are thicker, the flanges wider and much thinner, the flange bevel flatter, and the web-enlargement at the flanges reduced in size. The beams are all a pound or two heavier than the high-efficiency beams, and their carrying capacity per pound is lower (though equal to that of the "standard-weight" I-beams). The 24-in. I-beam, for instance, has 7-in. flange and ½-in. web in the old "standard-weight" section weighing 80 lb. per ft.; 7-in. flange and $^{25}/_{64}$-in. web in the high-efficiency section weighing 69½ lb.; 9-in. flange and $\frac{17}{32}$-in. web in the new section weighing 74 lb.

A pamphlet "Structural Beams," describing the new sections, has just been issued by the Carnegie Steel Co., Carnegie Building, Pittsburgh, Penn.

Organization of Pan-American Scientific Congress

A second Pan-American Scientific Congress will be held in Washington, D. C., Dec. 27, 1915, to Jan. 8, 1916. The program is divided into nine main sections, of which the fifth is Engineering and is in charge of Gen. W. H. Bixby. (The others cover anthropology, astronomy, natural resources, education, law, mining, public health and transportation.)

The secretary of the engineering section is Elmer L. Corthell. The section will concern itself in particular with discussion of various engineering subjects that commanded the attention of the delegates to the Santiago Congress of 1908. Among these is "a common Pan-American body of engineering nomenclature and laws regulating the use of water." Another subject to be discussed is the desirability and practicability of establishing a uniform railroad gage in Pan-America, especially in Central and South America. The five principal engineering societies of the United States have delegated their secretaries to represent them.—By G. L. Swigett, Assistant Secretary General, Second Pan-American Scientific Congress.

On the Pacific Coast Special

[*Editorial Correspondence*]

Members of the four national societies of civil, mechanical, mining and electrical engineers left New York City for San Francisco on Thursday, Sept. 9, on a special through train of 13 steel cars over the New York Central lines and Santa Fé system. The entire party, with those who joined at Albany, Buffalo, Cleveland and other points, numbered over 150.

Among the prominent members of the party were: Dr. John A. Brashear, President of the Mechanical Engineers, and William L. Saunders, President of the Mining Engineers; Gano Dunn, President of the United Engineering Society; H. J. E. Wenckebach and Robert Snellen, delegates from Holland to the International Engineering Congress; Major Jean de Pulligny, delegate of the French Government; Prof. A. E. Rohn, of the Zurich Polytechnic Institute, delegate from Switzerland; Roger Tappan, from Finland; W. Charnley, from Brazil; and José R. Villalon, from Cuba; Prof. Ira H. Woolson, S. L. F. Deyo, D. H. Grimm, C. F. Rand, Lazarus White, W. N. Best, Mansfield Merriman and J. J. Carty, of New York; Worcester R. Warner, of Tarrytown; H. G. Reist, of Schenectady; J. A. Seymour, of Auburn; Gardner Williams and C. F. Loweth, of Chicago.

Friday forenoon was spent at Niagara Falls, with a trip over the Niagara Gorge Ry. to Lewiston. Very hot weather prevailed the first two days, but heavy rains Friday night cooled the air and gave the travelers an opportunity to see the streams of northern Missouri and eastern Kansas in high flood.

Colorado Springs was reached on Sunday morning, Sept. 10. Most of the party spent the morning in an excursion by automobiles to Crystal Park, a mountain valley 2,750 ft. above the city plain. The park is reached by a new automobile road with 8% maximum grades. The road zigzags back and forth, and at three places, where the slope was too steep for grading wide enough to make a hairpin turn, a Y has been made. The company which built the road runs 20-passenger automobiles over it.

An excursion up Pike's Peak was attempted by most of the party in the afternoon, but the breakdown of the rack locomotive after the first half mile compelled a return. A number, by invitation of the Portland Mining Co., motored to Cripple Creek. Several others went over the new automobile road which is under construction to the top of Pike's Peak, and of which about 30 mi. has been completed.

Monday was spent crossing New Mexico, where remarkable sandstone cliffs were a source of great interest. The train arrived early Tuesday morning at the Grand Cañon of the Colorado River, and the visitors had the entire day to view this indescribable wonder.

Tuesday night and Wednesday were spent between the Grand Cañon and San Francisco, the most interesting

engineering feature being the famous Tehachapi Pass over the Sierra Nevada range. From the summit of the pass to Bakersfield, a distance of 50 mi., the railway descends 3,550 ft. The location is along steep hillsides where numerous tunnels and horseshoe curves and one complete loop were necessary.

At Albuquerque the travelers were greeted by a local committee representing the engineers of New Mexico; and as the train approached San Francisco on Wednesday afternoon, members of the local reception committee came out to extend a welcome. The remaining days of the week after arrival at San Francisco were occupied by the meetings of the several national societies, and the week following to the International Engineering Congress.

The Worst Slide at Gaillard Cut, Panama Canal, occurred on the east bank, just north of Gold Hill and directly opposite the village of Culebra, on Sept. 18. An upheaval of the bottom of the canal is alleged to have taken place at the same time, forming an island in the middle of the channel, closing the latter to navigation.

Reduction in Number of Accidents has been secured by the Baltimore Gas and Electric Co. as a result of the work of its safety committees. There were no accidents fatal to the public in the year ending June 30, 1915, and the total number of nonemployees injured was reduced from 102 to 25. However, four men were killed compared with one the year before. The total number of accidents was 330, a reduction of 30%; the number of employees injured was 301, or 17% reduction.

An Explosion Wrecked the sewage-pumping station of Batavia, N. Y., on Aug. 18, fatally injuring an employee and putting out of commission the pumps which lift the sewage of the city to sewage-treatment works. It is supposed that the explosion was caused by either natural gas or gasoline that gained access to the pump-well through the sewers. Thomas Fleming, Jr., of Chester & Fleming, Pittsburgh, was called in to advise the city immediately after the explosion. H. J. Burkhart is Mayor of Batavia.

A Large Contract for Stone Ballast for a portion of the new subway system for New York City has been awarded by the Public Service Commission for the First District. About 243,000 cu.yd. of hard-limestone ballast will be supplied by the Upper Hudson Stone Co. for $228,010, or about $0.94 per yd.

Grinding the Rails of Street Railways by means of the track brakes used on steep grades is being practised at San Francisco. The ordinary wood blocks or shoes of the track brakes are replaced by carborundum blocks and the cars are run at regular speed with the brakes set sufficiently to cause the blocks to grind the rail heads.

Railway Scale-Testing Cars of large and short wheelbase were discussed by C. A. Briggs, of the United States Bureau of Standards in a paper read at the Chicago meeting of the National Association of Scale Experts. His conclusions were unfavorable to the longer double-truck cars and in favor of four-wheeled cars. The wheelbase preferably should be 5 or 5½ ft., with 7 ft. as a maximum.

The First Cargo of American Coal for Greece was shipped from Norfolk, Va., in July. The collier proceeded to Patras where 3400 tons was discharged, then to Paræus, where the remaining 2600 tons was discharged. The price of the coal is stated to have been $15.07 per ton c.i.f. Patras, of which $11.42 was for ocean freight and $3.65 for the coal itself. The annual consumption of coal for the Patras district is 60,000 to 80,000 tons, practically all bituminous.

A Weather Bureau Station has just been established on a farm near Omaha, Neb., for the purpose of making systematic observations of the upper air, by means of kites carrying self-recording instruments. It was not necessary to erect new buildings, excepting a small shelter for the kite reel, as the buildings on the farm were sufficient for the needs of the work. This work was formerly carried on at Mount Weather, Va., and the apparatus was moved from that station to the present one. This station will be known as the Drexel Aërological Station, and the observations obtained here will be sent to the Central Office of the Weather Bureau at Washington, D. C., for computation and study. Kite flights were begun at this station Sept. 1.—B. J. Sherry, Drexel, Neb.

The Largest Municipal Office Building in the world is the new Municipal Building of New York City. According to the report of Borough President M. M. Marks, the building contains about 1,000 offices, which are occupied by over 4,2[illegible] city officers and employees. The force employed for cleaning, maintaining and operating the building is under the 8-h[illegible] law and other restrictions, which make it difficult to secure economy. Nevertheless, the estimated annual cost for daily cleaning, watching and attendance for 1915 is onl[illegible] 11.9c. per sq.ft. There is in the entire building 830,000 sq.f[illegible] of floor area. The estimated total cost of operation and maintenance for 1915, including heating, lighting and elevator service, is 29¾c. per sq.ft. of floor area and 49c. per sq.ft. of office area.

Shipbuilding in Nagasaki, Japan, has become an industry of great importance since the opening of the Panama Canal and the withdrawal of many European vessels from active service. Although Oregon pine costs 70 to 75 per cent. more than the native pine, it is preferred for shipbuilding purposes because of its fewer knots and more regular grain. These characteristics result in a reduction of labor cost, which is an important factor in Japan, where the cost of labor is high compared with other places in the Far East. The Japanese ship's carpenter receives the equivalent of 30c. to $2 per day, according to his degree of skill, while in certain parts of China an expert carpenter receives less than 10c., United States currency. The largest single shipment of Oregon pine to Nagasaki is now on its way and consists of 2000 tons of timber.

A Large Coal-Loading Wharf is under construction in New Castle Harbor, New South Wales. It will be one-third mile long, with water 30 ft. deep along the face line. A system of heavy diagonal bracing is employed between the superstructure and the high-water mark, for the purpose of preventing the traverse rail from being knocked out of alignment by heavy vessels. The dock will carry six 15-ton coal-loading high-speed electric traveling cranes, each weighing 200 tons, of English manufacture. Two have been delivered, and a third is on the way. The following data are from a report on the test of these machines:

Hoisting with two motors: Load, 15 tons; speed, 97 ft. per min.; 480 volts, 240 amperes. Hoisting with one motor: Load, 15 tons; speed, 47.6 ft. per min.; 270 volts, 110 amperes. Traveling: Speed, 97 ft. per min.; 488 volts; 48 amperes.

For hoisting, 154 hp. was required; 7¾ hp. for slewing, and 31½ hp. for traversing. Each of the cranes will lift 15 tons at 55-ft. radius a vertical distance of 39 ft. It is estimated that the six cranes will be able to load over 2,500,000 tons of coal per annum.

PERSONALS

Mr. R. S. Bryant, Consulting Engineer of the Standard Welding Co., of Cleveland, Ohio, has become Factory Manager of the company.

Mr. Joachim G. Giaver has opened an office in the Railway Exchange Building, Chicago, Ill., where he will engage in structural engineering.

Mr. Charles L. Wood, formerly with the United States Coast and Geodetic Survey, has been appointed Highway and Bridge Engineer of Lowndes County, Mississippi.

Mr. Thomas B. Smith, formerly Postmaster of Philadelphia, has been appointed a member of the Public Service Commission of Pennsylvania by Governor Brumbaugh.

Mr. F. K. Bennett, Supervisor of the Minneapolis & St. Louis R.R., at Monmouth, Ill., has been made Valuation Engineer, with headquarters at Minneapolis, Minn.

Mr. Gus E. Hauser, Jr., of Columbus, Miss., has been appointed consulting engineer for the $100,000 bond issue for highway construction in Lowndes County, Mississippi.

Mr. Charles A. Russell, of Gloucester, Mass., has been appointed a member of the Massachusetts Public Service Commission, to fill the vacancy caused by the retirement of Mr. Clinton White.

Dr. Otto Kress will hereafter have charge of the pulp and paper investigations at the United States Forest Products Laboratory at Madison, Wis. He succeeds Mr. O. L. E. Webber, who recently resigned.

Mr. Herman L. Wittstein, Jun. Am. Soc. C. E., Efficiency Engineer of the Knox Motors Co., Springfield, Mass., has become Assistant to the Manager of the Standard Fuse Corporation at Paulsboro, N. J.

Dr. Robert P. Calvert, Instructor of Chemistry at Columbia University, has been appointed Director of the Laboratory of

General Chemistry at the Experiment Station of the E. I. du Pont de Nemours Powder Co., of Wilmington, Del.

Mr. Charles B. Buerger, M. Am. Soc. C. E., Principal Assistant Engineer with Mr. George W. Fuller, New York City, has resigned to accept an appointment as Consulting Engineer of the Atlantic Refining Co., of Philadelphia, Penn.

Mr. J. P. Walker, Assistant Engineer of the Valuation Department of the Atlantic Coast Line at Petersburg, Va., has been made Assistant Superintendent of the Charleston district of that road, with headquarters at Charleston, S. C.

Mr. Nelson Ogden, Assoc. M. Am. Soc. M. E., who was engaged for a number of years with the New London Ship and Engine Co. on the design of Diesel oil engines, has accepted a position with the McIntosh & Seymour Corporation, of Auburn, N. Y.

Mr. William C. Coffin, M. Am. Soc. M. E., recently Structural Engineer of the Jones & Laughlin Steel Co., Pittsburgh, Penn., has been elected Vice-President of the Knox Pressed & Welded Steel Co., Pittsburgh. From 1898 to 1908 he was Vice-President of the Riter-Conley Manufacturing Co.

Mr. Edward Anderberg, Assoc. M. Am. Soc. C. E., Assistant Engineer, New York State Barge Canal, in charge of bridge and lock work, at Lockport, N. Y., has been appointed Resident Engineer at New York City, in charge of terminal construction. He succeeds Mr. Earl Talbot, who recently resigned.

Prof. Frederick H. Newell, M. Am. Soc. C. E., the new head of the civil engineering department of the University of Illinois, and formerly Director of the United States Reclamation Service, has been appointed a member of the Illinois State Board of Examiners of Structural Engineers, by Governor Dunne.

Prof. Alexander Miller Gray, Assistant Professor of Electrical Engineering at McGill University, Montreal, has been appointed Professor of Electrical Engineering in Sibley College, Cornell University. He will also be the head of the electrical department, filling the vacancy caused by the resignation of Prof. H. H. Norris.

Dr. M. X. Sullivan, who has been connected with the Division of Soil Fertility of the United States Department of Agriculture, at Washington, D. C., has accepted the position of biological chemist of the United States Public Health Service. He will be engaged in the biochemical study of pellagra at the pellagra hospital in Spartanburg, S. C.

Mr. William E. Keily, Assoc. Am. Inst. E. E., until recently Associate Editor of the "Electrical World," at Chicago, has opened an office in the Edison Building, 72 West Adams St., that city, where he will engage in consulting work in public-utility development. From 1910 to 1914 Mr. Keily was Editor of the "Convention Daily," published at the annual conventions of the National Electric Light Association held at St. Louis, New York, Seattle, Chicago and Philadelphia. Previous to his connection with the "Electrical World," he was Managing Editor of the "Western Electrician" of Chicago.

OBITUARY

Sereno S. Pratt, of Brooklyn, N. Y., for the last five years Secretary of the Chamber of Commerce of New York City, died recently at his summer home at Dorset, Vt.

Charles Hawlett Wing, Professor and head of the Department of Chemistry of the Massachusetts Institute of Technology from 1874 to 1884, died in Boston on Sept. 14, at 80 years of age. He was Professor of Chemistry at Cornell University previous to his connection with the Technology.

Gen. Edward H. Ripley, founder and Director of the United States and Brazil Steamship Line, died at Rutland, Vt., on Sept. 14, after a long illness. He was the builder of the Raritan River R.R. and various structures in New York City. He left Union College to enter the Union army as captain of volunteers and was rapidly promoted to the rank of brigadier-general.

William F. Fitch, formerly President of the Duluth, South Shore & Atlantic R.R., died at his home in Marquette, Mich., on Sept. 16, at 76 years of age. Mr. Fitch was born in Circleville, Ohio, and in 1871 began his railroad career as a clerk in the employ of the Chicago & Northwestern Ry. In 1888 he entered the service of the Duluth, South Shore & Atlantic. At various times he was also President of the Mineral Range R.R., General Manager of the Calumet & Hancock R.R., and President of the Lake Shore Terminal & Transfer Ry. In 1902 he became Vice-President of the Wisconsin Central Ry.

John Howard Van Amringe, Dean Emeritus of Columbia College, died at the age of 79 years at the Keeler House, Morristown, N. J., on Sept. 10, from a stroke of apoplexy. He was born at Philadelphia, and received his education at the Montgomery Academy, in Orange County, N. Y., Yale and Columbia colleges. He devoted almost his entire time for fifty years to the interests of Columbia, and retired only five years ago. He was the author of a "History of Columbia College" and contributed the Columbia section to the volume known as "Universities and Their Sons." Some years ago he edited a series of Davies' mathematical works; at one time he was president of the New York Mathematical Society.

ENGINEERING SOCIETIES

COMING MEETINGS

NORTHWESTERN ROAD CONGRESS
Oct. 4-7. At Cedar Rapids, Iowa. Secy., Jas. P. Keenan, Milwaukee, Wis.

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION.
Oct. 11-12. Secy., Will P. Blair, Engineers Bldg., Cleveland, Ohio.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 12-14. Annual convention at Dayton, Ohio. Secy., Charles Carroll Brown, 702 Wulsin Bldg., Indianapolis, Ind.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 19-21. Annual meeting, at Detroit, Mich. Secy., C. A. Lichty, 319 N. Waller Ave., Chicago.

SAN FRANCISCO MEETINGS

ILLINOIS GAS ASSOCIATION.
Sept. 27. Adjourned meeting. Secy., H. H. Clark, 72 West Adams St., Chicago, Ill.

SAFETY CONFERENCE.
Sept. 27-30. A. C. Carruthers, Vice-Pres., Collective Insurance & Universal Safety Exhibit, Mines and Metallurgy Bldg., San Francisco.

INTERNATIONAL GAS CONGRESS.
Sept. 27 to Oct. 1. Secy., George C. Ramsdell, 29 West 39th St., New York City.

AMERICAN GAS INSTITUTE.
Sept. 27 to Oct. 1. Secy., George C. Ramsdell, 29 West 39th St., New York City.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 4-9. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN ELECTRIC RAILWAY MANUFACTURERS' ASSOCIATION.
Oct. 4-9. Secy., H. G. McConnaughy, 165 Broadway, New York City.

National Conference on Concrete-Road Building—This meeting will be held in Chicago, Feb. 15-18, 1916. The notice in the issue of Sept. 9 gave the date as Sept. 15-18.

The Society to Promote the Science of Management will hold a special memorial meeting in honor of Frederick W. Taylor on Oct. 22, at 8:15 p.m., in Houston Hall, University of Pennsylvania, Philadelphia. There will be several speakers who have been closely associated with Mr. Taylor at different periods of his career. The secretary is Prof. Henry W. Shelton, Hanover, N. H.

Electrical Dealers' and Contractors' Association of Ontario—The annual convention was held in Toronto, Can., Sept. 6-9. The following officers were elected: President, J. W. Commeford, Toronto; First Vice-President, William Greenleaf, Belleville; Second Vice-President, J. R. Zenorble, Windsor; Secretary, Rufus Earle, Toronto; Treasurer, J. C. Soules, Toronto. The place of meeting for next year was left to the decision of the Executive Committee.

Northwestern Branch of the American Society of Civil Engineers—The Northwestern Branch held its annual meeting on Sept. 17 in St. Paul, Minn. After a dinner the following officers were elected: President, W. L. Darling, Chief Engineer of the Northern Pacific Ry., St. Paul; First Vice-President, George L. Wilson, Chief Engineer of the Twin City Rapid Transit Co., Minneapolis; Second Vice-President, L. W. Rundlett, St. Paul; Secretary, R. D. Thomas, Minneapolis; Treasurer, A. F. Meyer.

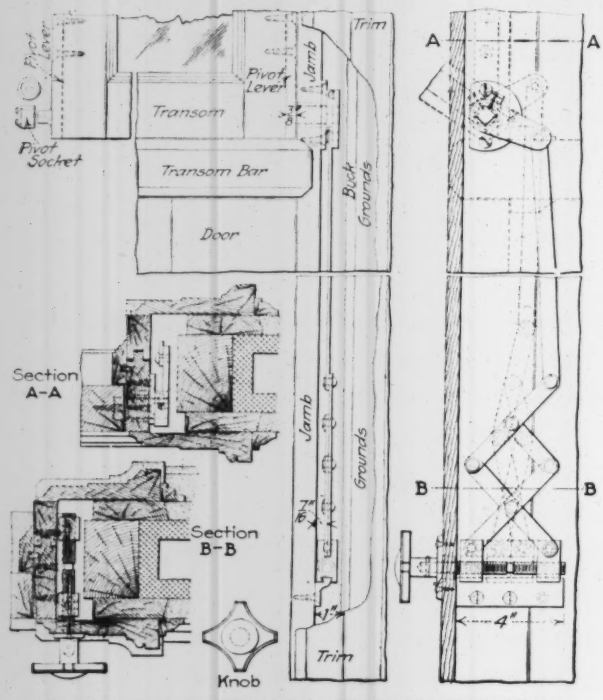
Institute of Paving Brick Manufacturers—This society was recently organized with the following officers: President, F. R. Kanengeiser; Vice-President, D. E. Humphrey; Secretary, Robert Keplinger, Metropolitan Paving Brick Co., Canton, Ohio; Treasurer, Spencer M. Duty. A meeting was held at Alton, Ill., on Sept. 22. This society was organized for the benefit of brick makers, men and companies of allied occupations being admitted only to associate membership. Only active members constitute the board of directors. Officers must be active members and no two of them can be identified with the same concern. The dues of an active member are $20 per year, while an associate member pays $5 per meeting

The American Institute of Consulting Engineers is the first engineering organization to join the Chamber of Commerce of the United States. The Institute will coöperate with the Chamber in its activities for the development of industry and commerce. The Institute is the only engineering organization that has membership in the Chamber.

Appliances and Materials

Concealed Transom Operator

A new type of concealed transom operator involving no gears, bolts or exterior rods is being installed in some of the newer buildings. The design comprises lazy tongs, a reach rod and a bell crank as shown in the accompanying sketch. The first complete turn of the operating knob noiselessly opens the transom to an angle of 20 deg. This operator is for bottom-, center- or top-hung transoms and is adjustable to every style and size. The maker, the Tabor Sash & Fixture Co., 61 Polk St., Newark, N. J., claims that the device requires no oiling or attention after installation and that the working parts are rust-proof. The entire device can be removed by loosening the screw on the top clamping level after the trim is removed.



NEWBERTH CONCEALED TRANSOM-OPERATOR

* * *

An Electric Harbor Range Light, made by the Esterline Co., of Indianapolis, and known as the "Golden Glow" light, has been installed by the United States Lighthouse Bureau at Vidal Shoals, at Two Harbors and at other points on the Great Lakes, and is shortly to be installed in the Philadelphia harbor. In this light a deep parabolic reflector is used, made of glass of a yellowish green color. The silvering is done on the outer surface of the reflector. The light from the lamp passes through the glass and is reflected back again from the silvered surface; the blue and violet rays are absorbed, and the yellow rays which are reflected are claimed to have special power to penetrate fog. Similar reflectors are made for locomotives, electric-railway cars, searchlights, etc. In the harbor range lights 94- to 151-watt incandescent tungsten lamps are used.

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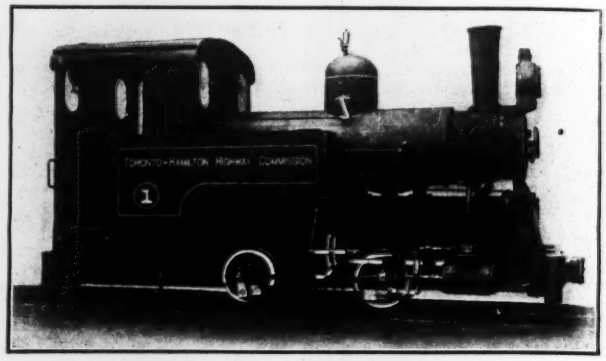
Dinkey Locomotive with Underhung Tank

The interesting type of dinkey locomotive shown herewith is one of three built by the H. K. Porter Co., of Pittsburgh, Penn., for the Toronto-Hamilton Highway Commission for use on road construction. The special features are the use of plate frames and the utilization of these frames to form the sides of an underhung water tank, forward of the firebox. This gives a lower center of gravity than can be obtained with a saddle tank over the boiler, and results in greater steadiness on rough tracks.

The engine is for track of 24-in. gage. While it weighs only 7½ tons, it has a tractive effort as high as 3435 lb. It



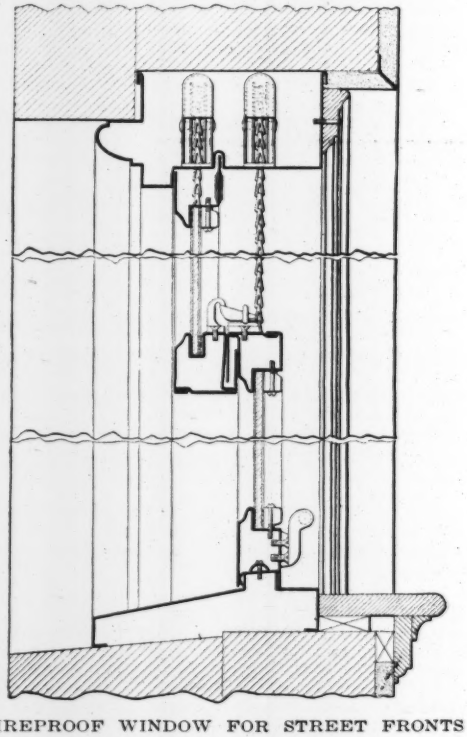
DINKEY LOCOMOTIVE WITH PLATE FRAMES AND UNDERHUNG TANK

is 14½ ft. long, 8 ft. wide, and 8½ ft. high overall. The cylinders are 7x10 in., with slide valves and the Walschaerts valve gear. The driving wheels are 20 in. diameter, with a wheelbase of 4 ft. The boiler is 25 in. diameter, and carries a pressure of 165 lb. A coal bunker of about 500-lb. capacity is placed at one side of the boiler.

* * *

Heavy Double-Hung Window

A new steel street-front window is manufactured by the S. H. Pomeroy Co., Inc., New York City, which is three times as heavy as the usual fire-retardant windows produced by this company. It can be supplied with either single- or multi-light sash, with or without glass in place. Wearing parts are



FIREPROOF WINDOW FOR STREET FRONTS

replaceable. The details of the double-hung window are shown in the accompanying cross-section drawing. The window is applicable to office buildings, loft buildings, hotels and apartment houses.